

2

Measurement of physical activity for public health purposes: validity and reliability of the International Physical Activity Questionnaire (IPAQ)

by

Isabelle Marie Therese Bohlmann

**A dissertation submitted to the faculty of Medicine, University of Cape
Town, in fulfillment of the requirements for the Degree of Master of Exercise
Science. August 2001.**

**MRC/UCT Research Unit for Exercise Science and Sports Medicine,
University of Cape Town, Sports Science Institute of South Africa.**

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

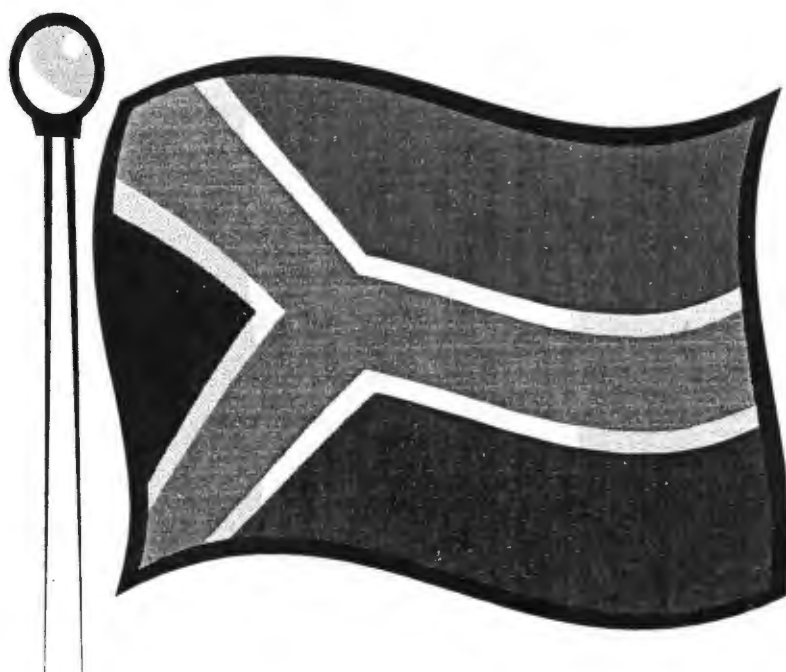
*"Health is a state of complete well-being. It is
not merely freedom from disease and
infirmity"*

Oxford Dictionary of Sport Science and Medicine.

*"Physical activity may not add many years to
life, but more importantly, may add life to
years."*

*Dr Peter G. Snell
(Circulation. 1999; 100: 2 - 4)*

Product of the Republic of South Africa



This thesis forms part of an international research initiative.

DECLARATION

I, **Isabelle Marie Therese Bohlmann** (nee Hargreaves), hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise), and that neither the whole work, nor any part of it has been, is being, or is to be submitted for another degree in this or any other University.

I empower the **University of Cape Town**, South Africa, to reproduce, for the purpose of research, either the whole or any portion of the contents in any manner whatsoever.

Signed by candidate

Signature removed

Signature

13/08/2001

Date

TABLE OF CONTENTS

	PAGE
DECLARATION	i
TABLE OF CONTENTS	ii
LIST OF FIGURES	vii
LIST OF TABLES	ix
LIST OF ABBREVIATIONS AND TERMINOLOGY	xiii
ACKNOWLEDGEMENTS	xx
PUBLICATIONS ARISING FROM THIS THESIS	xxii
THESIS ABSTRACT	xxiii
DEFINITIONS	1
a) Epidemiology, physical activity and physical activity epidemiology	1
b) Validity and reliability of physical activity questionnaires	3
c) Physical activity questionnaires- what exactly are we measuring and interpreting?	8
References	11
 CHAPTER ONE: BACKGROUND TO THE STUDY	 15
References	18
 CHAPTER TWO: LITERATURE REVIEW	 20
2.1 INTRODUCTION	20
2.2 PHYSICAL ACTIVITY QUESTIONNAIRES	20
2.2.1 Introduction	20
2.2.2 Validation methods of physical activity questionnaires	24
2.2.3 Direct methods of validation	24
a) Doubly labeled water	24
b) Behavioral observation techniques	26
c) Diaries and logs	28

d) Movement assessment devices	30
e) Heart rate	34
2.2.4 Indirect methods of validation	37
2.2.5 Summary of validation methods	38
 2.3 SOURCES OF ERROR AND BIAS IN PHYSICAL ACTIVITY	 41
ASSESSMENT BY SELF-REPORT/QUESTIONNAIRE	
2.3.1 Characteristics of the respondent	41
Body composition	41
Age and gender	42
Climatic conditions	43
Habitual level of physical activity	43
Memory	44
Intensity of physical activity	45
Perceived exertion	46
2.3.2. Characteristics of the assessment tool	47
Gender and occupation considerations	47
Defining physical activity	49
2.3.3. Sources of error in the assessment of physical activity in South Africa.	50
2.3.4. Summary of sources of error and bias in physical activity assessment.	51
 2.4 PHYSICAL ACTIVITY AND HEALTH	 51
2.4.1 Physical Activity patterns and trends in epidemiological studies	51
Socio-economic status	52
Gender and ethnicity	52
Age	54
Physical activity patterns	54
Occupation	55
Body composition	56

Health habits	56
2.4.2. Relationship between physical inactivity and chronic diseases:	57
How much is enough?	
Use of absolute cut-points to classify physical activity	65
2.5. SUMMARY OF THE LITERATURE REVIEW	66
2.6. AIM OF THE STUDY	68
References	68
 CHAPTER THREE: SELF-SELECTED MODERATE AND VIGOROUS WALKING PACE AND RELATIVE INTENSITY	 83
 Abstract	 84
Introduction	85
Methods	88
Subjects	88
Experimental protocols: first visit.	88
Second visit	89
Questionnaire	90
Statistical methods	91
Sample size determination	93
Results	93
Subject characteristics	93
Gender differences for self selected walking pace	94
Age related differences in self selected walking pace and relative intensity	99
Demographic variables and walking pace and intensity	100
Other factors associated with walking pace and intensity	100
Simultaneous multiple linear regression analysis	103

Discussion	106
Gender differences in walking	109
Height and speed of walking	110
Age and self-selected walking	110
Effect of fitness on walking pace and intensity	111
Demographic and cultural effects on walking	112
Language, social desirability and cultural effects on walking	113
Summary	113
References	114
 CHAPTER FOUR: VALIDITY AND RELIABILITY OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ) IN AN URBAN SOUTH AFRICAN POPULATION USING THE COMPUTER SCIENCE AND APPLICATIONS, INC (CSA) ACTIVITY MONITOR.	 124
Abstract	125
Introduction	127
Methods	129
Subjects	129
Experimental protocols	130
The accelerometer	130
The step test	131
The Questionnaire	131
Visit one	133
Visit two	133
Visit three	134
Statistical analysis	134
Results	136
Descriptive statistics	136
Test-retest reliability	141
Validity	144

Criterion validity	145
Limits of agreement	146
Discussion	161
Conclusion	175
References	176

CHAPTER FIVE: CONCLUSION OF THIS THESIS	184
References	186

LIST OF APPENDECES:

APPENDIX 1. Abstracts arising from this thesis	
APPENDIX A. Advertisement	
APPENDIX B. Subject information and informed consent	
APPENDIX C. Medical history and demographic questionnaire	
APPENDIX D. IPAQ draft 6 for chapter three	
APPENDIX E. Data collection sheets	
APPENDIX F. Subject report back	
APPENDIX G. Protocol for chapter three	
APPENDIX H. Pilot study results	
APPENDIX I. IPAQ forms for chapter four.	
APPENDIX J. Abstract of ACSM presentation	
APPENDIX K. IPAQ in Afrikaans and Xhosa	
APPENDIX L. Specific recommendations arising from this study	

LIST OF FIGURES.

PAGE

CHAPTER TWO:

Figure 2.1 Age-adjusted prevalence (per 100) of no leisure-time physical activity of the U.S. population, 20 years of age or older, 1988- 1991. 53

Figure 2.2. The dose-response curve represents the best estimate of the relationship between physical activity and health benefits. The lower the baseline physical activity status, the greater will be the health benefit associated with a given increase in physical activity (arrows A, B and C) Pate et al. 1995. 58

CHAPTER THREE:

Figure 3.1. Vigorous walking pace ($\text{km}\cdot\text{hr}^{-1}$) (a) and relative intensity (% age-predicted HR max) (b): age and gender effects. 97

Figure 3.2. Moderate walking pace ($\text{km}\cdot\text{hr}^{-1}$) (a) and relative intensity (% age-predicted HR max) (b): age and gender effects. 98

CHAPTER FOUR:

Figure 4.1. Energy expenditure ($\text{MET min}\cdot\text{wk}^{-1}$) (\pm SEM) for the long IPAQ in visit one (V1), visit two (V2) and visit three (V3). 153

Figure 4.2. Energy expenditure ($\text{MET min}\cdot\text{wk}^{-1}$) (\pm SEM) for the short IPAQ in visit one (V1), visit two (V2) and visit three (V3). 153

Figure 4.3. Limits of agreement for moderate physical activity in the long IPAQ on visit one (V1) and visit two (V2). 158

Figure 4.4. Limits of agreement for vigorous physical activity in the long IPAQ on visit one (V1) and visit two (V2).	158
Figure 4.5. Limits of agreement for total physical activity in the long IPAQ on visit one (V1) and visit two (V2).	159
Figure 4.6. Limits of agreement for moderate physical activity in the short IPAQ on visit one (V1) and visit two (V2).	159
Figure 4.7. Limits of agreement for vigorous physical activity in the short IPAQ on visit one (V1) and visit two (V2).	160
Figure 4.8. Limits of agreement for total physical activity in the short IPAQ on visit one (V1) and visit two (V2).	160

LIST OF TABLES

	PAGE
CHAPTER TWO:	
Table 2.1 Summary of evaluation of field methods of assessing habitual physical activity.	40
Table 2.2. The different physical activity classifications and energy expenditure of walking used in various questionnaires.	63
CHAPTER THREE:	
Table 3.1. Anthropometric, demographic and habitual physical activity characteristics of men and women (Mean \pm SD) (N = 102).	95
Table 3.2. Walking speed (km\cdothr⁻¹) and relative intensity (% age predicted HR max) at a self-selected moderate and vigorous walking pace in men and women.	96
Table 3.3. Percentage of subjects who walked below, within or over the pace/intensity recommended by the CDC/ACSM^a for moderate and vigorous activities (N = 102).	101
Table 3.4. Pearson-product moment correlations for factors associated with self-selected walking pace and relative intensity corresponding to “moderate” and “vigorous” activity.	102

Table 3.5a. Final model for multiple linear regression analysis of factors predicting variance in self-selected vigorous walking pace.	104
Table 3.5b. Final model for multiple linear regression analysis of factors predicting variance in self-selected moderate walking pace.	105
Table 3.6. Summary of factors which influence walking pace and relative intensity.	108
CHAPTER FOUR:	
Table 4.1a. Subject characteristics (\pm SEM).	137
Table 4.1b. Descriptive statistics (distribution) of the study population (N=81).	138
Table 4.2. Independent t- test to detect differences between men and women for the long IPAQ on visit one.	140
Table 4.3a: Intraclass correlation coefficients (ICC) for reliability assessment of the three administrations (day 1, 8 and 11) of the International Physical Activity Questionnaire (IPAQ) long format (N = 81).	147
Table 4.3b: Intraclass correlation coefficients (ICC) for reliability assessment of the three administrations (day 1, 8 and 11) of the International Physical Activity Questionnaire (IPAQ) short format (N = 81).	148

Table 4.3c. Test-retest reliability for long IPAQ between visit one and two- overall and for various demographic variables	149
Table 4.3d. Test-retest reliability of the short IPAQ between visit one and two- overall and for various demographic variables	150
Table 4.4a. Mean values (\pmSEM) of the long and short format of the IPAQ on visit one (N = 81).	151
Table 4.4b. Total physical activity quartile cut-points for the long and short IPAQ	152
Table 4.4c. Chi-squared analysis on total physical activity quartiles for the long and short IPAQ.	152
Table 4.5. Concurrent validity of the long IPAQ compared to the short IPAQ on the same administration.	154
Table 4.6. Spearman rank order correlation coefficients of the long IPAQ with variables measured in the study.	155
Table 4.7. Criterion validity: Long IPAQ energy expenditure compared to CSA activity monitor counts (N = 68).	156

Table 4.8. Criterion validity: Short IPAQ energy expenditure compared to CSA activity monitor counts (N = 68).	157
Table 4.9a. Comparison between the long IPAQ and MOSPA intra-class correlation coefficients.	164
Table 4.9b. Comparison between the short IPAQ and 14 Day recall intra-class correlation coefficients.	164
Table 4.10a. Correlation coefficients between physical activity domains, determined by physical activity questionnaires, and cardiorespiratory fitness in this and other studies.	170
Table 4.10b. Correlation coefficients between physical activity domains, determined by physical activity questionnaires, and BMI and body fatness, in this and other studies.	171
Table 4.11. Correlations between physical activity domains determined by physical activity questionnaires and average accelerometer counts.	174

LIST OF ABBREVIATIONS

ACSM:	American College of Sports Medicine.
BMI:	Body Mass Index.
CHD:	Coronary Heart Disease.
CSA:	Computer Science & Applications Inc. Activity Monitor (accelerometer).
CDC:	United States Centres for Disease Control and Prevention.
DLW:	Doubly labeled water.
EE:	Energy expenditure.
GTPA:	Grand total of time and energy spent in physical activity performed at WORK, HOME, TRANS and LTPA.
HOME:	moderate or moderately vigorous chores <i>in</i> and <i>around</i> the home (e.g. Housework, gardening, maintenance, caring for family).
HR:	Heart rate.
% HR_{max}:	Percentage of age predicted maximum heart rate.
IPAQ:	International Physical Activity Questionnaire.
LTPA:	Leisure time physical activity. Time and energy spent in physical activity for recreation, sport, exercise or leisure.
MET:	Multiples of resting metabolic rate, equivalent to $\sim 1 \text{ kcal} \cdot \text{kg} \cdot \text{h}^{-1}$.
NHANES III:	Third National Health and Nutrition Examination Survey (USA).
NIDDM:	Non Insulin Dependent Diabetes Mellitus.
PA:	Physical activity.
PAR:	Physical activity recall.
PAQ:	Physical activity questionnaire.

SD:	Standard deviation.
SEM:	Standard error of the mean.
SEE:	Standard error of the estimate.
SIT:	Time spent sitting while at work, at home or during leisure time (including time spent sitting travelling in a motor vehicle).
TDEE:	Total daily energy expenditure.
TRANS:	Walking or cycling to go from place to place (e.g. to work, movies or shopping).
VO₂max:	Maximal oxygen uptake.
WORK:	Walking or performing moderate and vigorous activities at work.
UKK:	Urho Kaleva Kekkonen Institute for Health Promotion Research (Finland).

LIST OF TERMINOLOGY

ABSOLUTE EXERCISE INTENSITY Absolute exercise intensity is independent of an individual's exercise capacity. Usually this is expressed as a walking speed, MET value or even resistance in Watts.

AEROBIC CAPACITY is the highest amount of oxygen consumed during maximal exercise in activities that use the large muscle groups in the legs or arms and legs combined. Aerobic capacity, maximal oxygen intake, functional capacity and cardiorespiratory fitness are terms that are often used interchangeably.

BODY COMPOSITION is a health-related physical fitness component that relates to the relative amounts of muscle, fat and bone.

BODY MASS INDEX (BMI; Quetelet Index): An estimate of body composition used especially in epidemiological studies: $\text{BMI} = \frac{\text{Weight in kg}}{(\text{height in metre})^2}$

The index has a positive correlation with skinfold measurements. It has been used as an indicator of obesity, on the assumption that the higher the index, the greater the level of body fat. However this assumption is not always true. When applying the index to some very lean individuals, such as weight lifters, they can be falsely classified as obese because of muscle bulk.

CHRONIC DISEASES OF LIFESTYLE (CDL): Also known as hypokinetic disease or non-communicable disease. These include coronary heart disease, obesity, hypertension, non-insulin dependant diabetes mellitus (NIDDM), Osteoporosis and hypercholesterolaemia amongst others. Physical activity has shown to have an inverse association with a variety of chronic diseases. However other lifestyle factors such as smoking, poor diet, alcohol consumption and high levels of stress all contribute to the development of chronic diseases of lifestyle. Heredity and age also play a significant role in the development of chronic diseases of lifestyle.

CORONARY HEART DISEASE (CHD): CAD is a disease that affects the coronary arteries. These are blood vessels which supply the heart with oxygen and nutrients which it needs to function. Slowly, over time, cholesterol and fatty substances build up in the walls of these vessels. This leads initially to the hardening of these walls which is known as atherosclerosis, and then to a narrowing of the blood vessels themselves.

This process progresses silently over the years. In some patients, the disease manifests itself through the appearance of stable angina pectoris or by silent ischaemia on effort. Others

may, however, only become aware that they have CAD when they have a myocardial infarct.

CORONARY HEART DISEASE RISK FACTOR: Coronary artery disease rarely develops from a single risk factor. Risk factors usually occur in clusters and may influence one another. Even a small increase in one becomes more critical when combined with others. Risk factors are divided into two main sections: 1) **Uncontrollable** risk factors for coronary artery disease include, gender, heredity and age. 2) The major **controllable** risk factors for coronary artery disease include hypertension, hypercholesterolaemia, smoking, physical inactivity, diabetes, stress, alcohol and obesity.

EXERCISE is planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness.

EXERCISE GUIDELINES relate to the type and amount of physical activity specific to intensity, frequency, and length of workouts needed to produce or maintain desired physical fitness objectives.

EXERCISE INTENSITY is often classified as a percent of aerobic capacity. *Moderate* exercise, referred to by the American College of Sports Medicine (ACSM) causes no discomfort, little increase in breathing and can be sustained comfortably up to 60 minutes. Moderate intensity has been described as 3- 6 METs (metabolic equivalent), which is the equivalent of brisk walking at three to four mph ($4.8 - 6.4 \text{ km}\cdot\text{h}^{-1}$) or at an energy expenditure of $17- 30 \text{ kJ}\cdot\text{min}^{-1}$. Moderate exercise is also defined as 40 to 60 percent of aerobic capacity. If intensity is uncertain, moderate exercise may alternately be defined as an intensity well within the individual's current capability. By ACSM definition, moderate

exercise can be comfortably sustained with a gradual progression for a prolonged period of time and is generally non-competitive. Vigorous exercise is defined by an exercise intensity that is greater than 60 percent of aerobic capacity. Vigorous intensity has been defined as > 6 METs, or the equivalent of walking > 6.4 km·h⁻¹, or as > 30 kJ·min⁻¹. See absolute and relative exercise intensity.

HEALTH: is a dynamic state that ranges from invalidism to optimal levels of functioning in all aspects of life. Health has been defined as a human condition with physical, social, and psychological dimensions, each characterized on a continuum with positive and negative poles (from the 1988 International Consensus Conference on Exercise, Fitness, and Health). Within this context, positive health is associated with life enjoyment and not merely the absence of disease. Negative health is associated with morbidity and at the extreme, premature mortality. “Ability of an individual to mobilize his or her resources—physical, mental, and spiritual—to the preservation and advantage of him or herself, and the dependents and society to which the individual belongs. Health is a state of complete well-being. It is not merely freedom from disease and infirmity”

Oxford Dictionary of Sport Science and Medicine.

LEISURE ACTIVITIES: “An activity, distinct from the routine obligations of work, family and society, in which an individual voluntarily takes part. A leisure activity may or may not be physically demanding. Leisure activities include watching and taking part in sport. It is generally agreed that leisure activities have strong socializing influences.”

MET—One MET is the amount of energy expended sitting quietly at rest adjusted to body weight (1 MET = 3.5 ml oxygen consumed/kg of body weight/minute). Also equal to 1 kcal·kg⁻¹·hour⁻¹. Physical activity intensity is often expressed in MET units. For example,

walking at a pace of 14 minutes per mile is expressed at an intensity of 6 METs or 6 times the energy expenditure required for sitting quietly at rest.

MORBIDITY is any departure, subjective or objective, from a state of physical or psychological well-being, short of death.

PHYSICAL ACTIVITY: is bodily movement produced by skeletal muscles that results in energy expenditure and is often associated with progressive health benefits. Physical activity has both an occupational and leisure basis that includes both active recreation pursuits like golf, tennis, and swimming. It also includes other active pastimes like gardening, cutting wood, and carpentry. Physical activity can be a catalyst for improving health attitudes, health habits, and lifestyle. The U.S. Public Health Service and other health professionals have suggested focusing promotional efforts upon the health-related fitness components.

PHYSICAL FITNESS: Physical fitness is the ability of the body to respond or adapt to the demands and stress of physical effort. "The ability of a person to function efficiently and effectively, to enjoy leisure, to be healthy, to resist chronic disease (hypokinetic), and to cope with emergency situations. Physical fitness relates to a set of attributes that people have or achieve that determine the ability to perform physical activity. The health related components of physical fitness include body composition, cardiovascular fitness, flexibility, muscular strength and endurance. Skill related components of physical fitness include agility, balance, co-ordination, power, reaction time and speed." *Oxford Dictionary of Sport Science and Medicine.*

RELATIVE EXERCISE INTENSITY is based on the exercise capacity of the individual and is expressed as a percentage of VO_2max , 1 repetition maximum, heart rate reserve or max VO_2 reserve.

REFERENCES

American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription*. 1995; Baltimore: Williams & Wilkins.

Casperson CJ, Powell KE, Christenson GM. Physical activity, exercise and physical fitness: definitions and distinctions for health related research. *Public Health Rep*. 1985;100:126-131.

Howley ET, Franks BD. *Health Fitness Instructor's Handbook*. 1997; Champaign, IL. Human Kinetics Publishers.

Kent, M. Oxford Dictionary of Sport Science and Medicine. Oxford University Press (1996).

Martin, E.A.(Ed).Concise Oxford Medical Dictionary. Fourth Edition. Oxford University Press (1996).

National Institutes of Health Consensus Development Conference Statement: Physical Activity and Cardiovascular Health. *JAMA* 1996; 17;276 (3):241-246.

ACKNOWLEDGEMENTS

I would like to thank the following people and institutions for their contribution towards my dissertation:

- **Professor Vicki Lambert** for her expertise and vision which made this research possible. Her understanding of the field and broad knowledge of public health has been very inspirational. Prof Vicki Lambert is totally committed to research and development in her field, and has set a wonderful example for others to follow. I thank her for the many long hours she spent editing my work and giving me guidance.
- **Professor Mike Lambert** for his input and editorial assistance. His exceptional eye for detail amazes me. I appreciate his helpful comments and objective opinion.
- This research project was funded by the **Medical Research Council of South Africa** and the Nellie Atkinson and Harry Crossley Staff Research Funds of the University of Cape Town. I am grateful to **MARS Confectionery U.K. Ltd.** for their contribution, as well as the **Medical Research Council of South Africa** for financial assistance in the form of a bursary for tuition fees.
- I would like to thank the **subjects** who participated in this study.
- The **researchers and lecturers** at the Sport Science Institute of South Africa for the high quality of their work that enables them to maintain international standards and recognition.
- The **post graduate students** at the Sport Science Institute of South Africa for the inspiration, encouragement and humor they provided.
- Thank you to **Jacob Manonyane** and **Bukiwe Peya** for their help with data collection and data capture for chapter three and four respectively.

- I would like to thank my husband, **Gordon**, who has supported me throughout this project. He has been incredibly understanding, patient and loving.
- My **family and friends** for their continued support and prayers.
- Lastly, but most importantly, I thank my **Lord**, Jesus Christ, because through him all things are possible.

PUBLICATIONS ARISING FROM THIS THESIS

Comparison between short and long version of the International Physical Activity Questionnaire (IPAQ). Isabelle M.T. Bohlmann and Estelle V. Lambert

Self selected moderate and vigorous walking pace, heart rate and relative intensity: implications for physical activity questionnaires. Isabelle M.T. Bohlmann, Estelle V. Lambert, Michael I. Lambert.

Published: The South African Journal of Sports Medicine (SAJSM) (6): 22-23 (Suppl September) 1999.

Presented:

- 8th Biennial Congress of the South African Sports Medicine Association (SASMA) September 1999
- All Africa Games Scientific Congress, Johannesburg, September 1999.

Is the International Physical Activity Questionnaire (IPAQ) valid and reliable in the South African population? I.M. Bohlmann¹, E.V. Lambert¹, S. MacKinnon², S. Kruger³, L. Leach⁴, J. Van Heerden⁵, I. Cook⁶, T.D. Noakes (FACSM)¹.

¹University of Cape Town, ² Rhodes University, ³Universities of Potchefstroom,

⁴Western Cape, ⁵Pretoria, ⁶University of the North, SOUTH AFRICA.

Presented: Poster presented by I. Bohlmann at the annual conference of the American College of Sports Medicine (ACSM), Baltimore, USA, May, 2001. Results from this thesis formed a part of this national study.

Self selected 'moderate' and 'vigorous' walking pace and relative intensity: understanding perception of effort. Bohlmann, I. M. T., Lambert, E. V., and Lambert, M. I. In review.

THESIS ABSTRACT

Physical inactivity is a well-recognized risk factor for chronic diseases of lifestyle and has been associated with an increased incidence of morbidity and mortality (2;3). Current recommendations for the “dose” of physical activity that may be regarded as “protective” for these chronic diseases are 30 minutes or more of moderate-intensity physical activity on most, or preferably all, days of the week (5). However, when quantifying physical activity, it is not clear which factors influence the reporting of moderate and vigorous activity levels. Even in the literature, there is lack of agreement on the energy expenditure corresponding to so-called ‘moderate’ and ‘vigorous’ physical activity.

Background (study 1): Self-reported physical activity levels are inversely related to chronic disease risk factors. The strength of this association depends, in part, on quantifying the intensity of activity that may be regarded as ‘moderate or vigorous’, which may be confounded by individual and cultural perceptions of relative exercise intensity, age, fitness, height, and habitual levels of activity. **Aim (study 1):** The purpose of this study was to i) examine the individual and group differences in self-selected walking pace corresponding to symptoms used to describe moderate and vigorous intensity and ii) to determine factors that may be associated with these differences.

Methods (study 1): A convenience sample of 63 women and 39 men were recruited (N=102). Subjects were asked to walk for six minutes on an indoor track at a pace they regard as ‘moderate’, rest until heart rate returns to pre-exercise levels, then walk at a pace they consider ‘vigorous’. Habitual levels of energy expenditure (EE), maximal oxygen consumption ($\text{VO}_{2\text{max}}$) and % fat were also determined. **Results (study 1):**

Mean self-selected walking pace for moderate activity levels was $5.54 \text{ km}\cdot\text{h}^{-1}$ (95% Confidence Interval (C.I.): 5.40; 5.69), and corresponded to 58% of age-predicted maximum heart rate (%HRmax) (95% C.I.: 56; 60). Mean self-selected vigorous pace was $7.03 \text{ km}\cdot\text{h}^{-1}$ (95% C.I.: 6.85; 7.20), at 72 % HRmax (95% C.I.: 69; 74). The %HRmax for both moderate and vigorous intensity physical activity fell within the ACSM recommendations (1) (55- 69%HRmax for moderate intensity activities, and 70 – 89 % HRmax for vigorous intensity activities). Multivariate analysis revealed that the factors predicting self-selected walking speed were gender, age, VO_2max , % fat and habitual vigorous EE. The only significant predictor of moderate pace was VO_2max . Education, occupation and habitual moderate EE were not associated with walking speed or intensity. **Conclusion (study 1):** These results show that subjects could accurately differentiate absolute and relative walking intensities and understood what was meant by the terms ‘moderate’ and ‘vigorous’. However, absolute pace and relative intensity may vary according to differences in gender, fitness, age, height, body fat % and habitual levels of vigorous activity. These factors are important to consider when prescribing exercise using descriptors such as “moderate” and “vigorous”.

Background (study 2): None of the various methods used to measure habitual physical activity in the general population have proven entirely satisfactory in terms of reliability and accuracy. A major problem is that no “gold standard” exists for the validation of various questionnaires that can be used in large sample population studies (4). Ongoing efforts to improve the validity and reliability of the measurement of physical activity by self-report will enable cross-cultural and international comparisons to examine secular

trends. **Aim (study 2):** The second part of this study assessed the validity and reliability of a recently developed International Physical Activity Questionnaire (IPAQ) which was interviewer-administered in both a short and long version, and queried activity performed in a “usual” week. **Methods (study 2):** Urbanized subjects (N = 82) were selected from a wide range of educational, activity level and socio-economic backgrounds. The long version IPAQ was designed to quantify the average weekly time and energy expenditure spent in occupation, transport-related activities, household chores, and leisure time activities. The short version IPAQ was designed to measure total weekly moderate, vigorous, walking and sitting related activity. Test-retest reliability was reported as the intra-class correlation between calculated time and energy expenditure ($\text{MET}_{\text{min}} \cdot \text{w}^{-1}$) in different questionnaire items determined from three IPAQ administrations. Validity was assessed using biometrical and physiological parameters as criterion measures (Computer Science and Applications. Inc. activity monitor counts, body mass index, estimated $\text{VO}_{2\text{max}}$, % fat). **Results (study 2):** Test-rest reliability coefficients for the long IPAQ ranged from $r = 0.38$ to $r = 0.75$, with the highest correlation coefficients obtained in work related activities, and the lowest in household chores. Test-retest reliability in the short IPAQ ranged from $r = 0.32$ to $r = 0.71$, with the highest correlations obtained for sitting and the lowest for total moderate activity. Criterion validity for CSA counts and total physical activity in the long IPAQ was $r = 0.50$ ($P < 0.001$), for CSA counts and total vigorous activity $r = 0.35$ ($P < 0.01$), and for CSA counts and total job activity $r = 0.51$ ($P < 0.001$). Measurement of reliability and validity in this South African population compared favorably to physical activity questionnaires used in other population studies. **Conclusion (study 2):** The IPAQ provides a relatively valid and reliable estimate of

physical activity in this population. In evaluating the relationship between physical activity and morbidity, it is important to consider the accuracy and reliability of the tool used to measure self-reported activity. Failure to show an association may represent a real phenomenon, or may simply reflect the inability of the physical activity questionnaire used to detect true physical activity levels.

Key words: absolute and relative intensity, validity, physical activity assessment, energy expenditure, IPAQ, walking speed, exertion, heart rate, energy expenditure, repeatability, accelerometer, moderate and vigorous physical activity.

References

1. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc.* 30: 975-991, 1998.
2. Bijnen, F. C., E. J. Feskens, C. J. Caspersen, N. Nagelkerke, W. L. Mosterd, and D. Kromhout. Baseline and previous physical activity in relation to mortality in elderly men: the Zutphen Elderly Study. *Am J Epidemiol.* 150: 1289-1296, 1999.
3. Blair, S. N. and S. Brodney. Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Med Sci Sports Exerc.* 31: S646-S662, 1999.

4. Haskell, W. L., M. C. Yee, A. Evans, and P. J. Irby. Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Med Sci Sports Exerc.* 25: 109-115, 1993.
5. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273: 402-407, 1995.

DEFINITIONS

a) Epidemiology, physical activity and physical activity epidemiology.

A clear definition of the term 'epidemiology' is given in the Oxford Medical Dictionary as *"the study of epidemic disease, with a view to finding means of control and future prevention. This not only applies to the study of such classical epidemics as plague, smallpox and cholera, but also includes all forms of disease that relate to the environment and ways of life. It thus includes the study of the links between smoking and cancer, and diet and coronary disease, as well as communicable diseases"* (11).

The traditional uses of epidemiology can be seen as fourfold. These uses are to:

- a) establish the magnitude of a health problem;
- b) identify the factor(s) that causes the health problem;
- c) develop a scientific basis for preventative activities or the allocation of health resources; and
- d) evaluate the effectiveness of preventative or therapeutic procedures (5).

From the above, it is understandable why epidemiological research is useful in establishing sound health policies. However, in order for the epidemiologist to research the area of physical activity and health, it is necessary to have measurement tools that accurately quantify physical activity levels in populations. A failure to accurately capture physical activity dose may affect the interpretation of physical activity as a positive or negative risk factor for disease.

The science of epidemiology is concerned with “*carefully quantifying the rate of health-related states or events that occur within the population being studied*” (5). The ultimate goal of the epidemiologist is to generalize this information to larger populations. This thesis is concerned with the methodology epidemiologists use to measure physical activity in order to come to conclusions on the health status of a population.

Descriptive epidemiology is concerned with establishing the rates of a disease or health-related event in a population. These data are often stratified according to age, sex, race, occupation, social class and geographic location (5). In contrast, *analytic epidemiology* identifies potential causative factors that may be associated with a disease or health related event (5). Physical activity is an example of a causative factor associated with health. This will be discussed in more detail in chapter two.

Physical activity has been defined by Caspersen et al. (1985) as “*bodily movement produced by skeletal muscles that results in energy expenditure and produces progressive health benefits*” (6). Physical activity can be divided into domains such as occupational, transportation, home/garden or sport/exercise/recreational physical activity.

Physical activity may include activities of daily living such as gardening, walking, house keeping, stair climbing, child minding or carrying objects. It is important to clearly differentiate physical activity from *exercise*, (which is a subcategory of physical activity). Exercise has been defined as “*physical activity that is planned, structured, and repetitive, and results in the improvement or maintenance of one or more components of physical fitness*” (6).

Assuming physical activity is a health-related behaviour and epidemiology is a discipline focusing on how diseases originate and are controlled in populations, then '**physical activity epidemiology**' is a specialist discipline focusing on: (a) the association of physical activity with disease and other health-related outcomes; (b) the distribution and the determinants of physical activity behaviour(s); and (c) the interrelationship of physical activity with other behaviours (5). Secondly, the discipline of physical activity epidemiology applies the research findings arising from studies described above to prevent and control disease and promote health (5).

b) Validity and reliability of physical activity questionnaires.

Although various methods used to measure habitual physical activity in the general population have been developed, none have yet proven entirely satisfactory in terms of accuracy and reliability. A major problem is that no "gold standard" exists for the validation of various questionnaires that can be used in large sample population studies (9).

Validity of measurement indicates the degree to which the test, or instrument, measures what it is supposed to measure (logical or face validity). Thus, validity refers to the soundness of the interpretation of a test, the most important consideration in measurement.

The different methods by which validity can be established are:

- **Criterion validity.** When a physical activity questionnaire is described as having logical validity, the assumption is made that the results of the questionnaire allow one to draw conclusions about the habitual physical activity patterns and therefore the health status of an individual. If this assumption was evaluated against a well-established assessment method e.g. a laboratory test of maximal oxygen consumption (VO_{2max}), and a strong correlation was found, then one could say that the physical activity questionnaire has criterion validity(16). (The criterion measure is presumed to be a more accurate measure of the characteristic of interest, although it may be more expensive or time-consuming to measure). Criterion validity is further divided into **concurrent validity**, which involves an instrument being correlated with some criterion that is administered at the same time (i.e. concurrently).
- **Construct validity.** A measurement with construct validity is one which generates results which can discriminate between different groups (e.g. sedentary vs. habitually active participants), who are presumed to have different fitness levels. Construct validity is the degree to which a test measures a hypothetical construct and is usually established by relating test results to some behavior (16). For instance, you would expect an athlete to obtain a high score and a sedentary individual to obtain a low score, on a physical activity questionnaire measuring habitual energy expenditure.

Reliability pertains to the consistency, or repeatability, of a measure. A test cannot be considered valid if it is not reliable (16). Reliability of a measure is usually estimated by some type of correlation coefficient (r). Reliability (r value) can range from 0.0 to 1.0, where 0.0 indicates no degree of reliability and 1.0 represents perfect reliability (i.e. the closer the coefficient is to 1.0, the less error variance it reflects). Intraclass correlation is another method of determining reliability based on repeated measures ANOVA (analysis of variance), which is sensitive to both order and magnitude of change in data (intraclass correlation may be used on three or more repeated measures). Intraclass correlation coefficients are calculated by: $MS_R - MS_{C+E} / MS_R$, where MS_R is the mean square of the variable of interest and MS_{C+E} is the sum of changes in the mean of the trials and the error (17). An intraclass correlation coefficient (R) greater than 0.90 is considered high, from 0.80 to 0.89 moderate to high, from 0.70 to 0.79 acceptable and below 0.70 questionable (17).

Described in medical terms, validity can also be an indication of the extent to which a clinical sign or test is a true indicator of disease. Reduced validity can arise if the tests produce different results when conducted several times on the same person or under identical conditions (i.e. *reduced reproducibility, reliability or repeatability*). This may be the result of *intra-observer error*, in which the same observer gets different results on successive occasions or *inter-observer error*, which arises when a series of different observers fail to obtain the same result. Such errors may arise because of a true difference in observation and/or interpretation or because of a preconceived notion (often unconscious) by the observer, which influences either his/her judgement or the tone and

manner with which he/she questions the subject (11). Significant correlations between $r = 0.40$ and $r = 0.60$ represent moderate levels of validity, and correlations below 0.30 are considered too small for the test or measure to be considered to be valid (13).

Reliability and validity of data collected may be affected by *cognitive factors* (such as a person's ability to store and retrieve information) (7), by *interviewer or respondent bias*, the time period being probed (the day, week or month), or the *sequence* of administration of the questionnaire within the battery of other measures collected (8). The impact of these, as well as sociodemographic and cultural issues, need to be addressed in future research on physical activity assessment (8).

When analyzing the reliability of a physical activity questionnaire there are three main areas that need to be considered: a) Questionnaire administration, b) data cleaning and c) data analysis. To ensure good test-retest reliability the above areas need to be standardized and methodologically correct. The areas discussed briefly below were considered in the *Workshop on the International standardization of physical activity assessment for public health purposes* (3):

- a) **Questionnaire administration.** (i) The *instructions to respondents* on how to complete a questionnaire should be standardized on all administrations, as well as responses to frequently asked questions. (ii) The *time between administrations* needs to be the same (for example two weeks apart). (iii) The *reference period* can either be

a short and specified period, for example the previous week or two weeks, or it can be more vague and ask the respondent to recall physical activity participation over a 'usual' week. In a previous study by Booth et al. (1996) repeatability was assessed on participant's recall of activity over different two-week time periods and over the same two-week time period (4). They found the variation in repeatability coefficients between recall of the same period (Intraclass correlation coefficient- ICC, $R = 0.86$) and activity recalled over different time periods (ICC, $R = 0.58$) was due to actual variation (natural fluctuation) in physical activity participation over different time periods, and not due to poor recall or poor measurement characteristics (4). (iv) The last consideration under questionnaire administration is the *sample size*. The calculation of statistical power is an important part of the research design, as it ensures that real differences between groups can be determined with the planned sample size. Research performed with insufficient statistical power (i.e. N is too small) may result in Type II error (17). To estimate statistical power, group mean differences and standard deviations must be estimated from pilot data or from prior research on similar subjects.

- b) **Data preparation.** (i) A large proportion of a study population may report no participation in physical activity at both test and retest measurements. These respondents would have identical zero values on both measurement occasions, potentially inflating the measures of reliability and masking the true reliability of self-reported activity among those who report some participation (4). One recommendation is that data is presented, both including and excluding those

respondents with zero values on both measurement occasions (3). Excluding data can result to data which is not normally distributed and lead to bias in interpretation. (ii) *Out-of-range values* (also known as outliers) may need to be excluded because they are unrepresentative scores. The possibility of under- or over-reporting should be acknowledged (10), however other reasons for outliers could also result from short attention spans, distraction and lack of motivation to complete the task (16).

- c) **Data analysis.** The choice of appropriate statistical methods is essential and will obviously have profound effects on the interpretation of results. The shortcomings and problems of commonly used methods of assessing the reliability of categorical and continuous data are discussed by Booth et al (4). Recommendations are also given such as the use of the kappa (K) statistic, which provides a measure of agreement corrected for chance agreements, for the assessment of categorical data, and the use of intraclass correlation (ICC) for assessing reliability in continuous data (3).

- c) **Physical activity questionnaires- what exactly are we measuring and interpreting?**
There are many different methods of assessing physical activity levels in population studies. The method of physical activity assessment is likely to affect prevalence estimates of meeting physical activity guidelines (14). Sarkin et al. (2000) demonstrated the difficulty of comparing prevalence rates across studies using different measures. They emphasized the fact that there is no well accepted standardized method of scoring physical activity data, and that there is a critical need to standardize measures of physical

activity used in population studies (especially since the choice of scoring protocol has such profound effects on prevalence estimates) (14). For example, the United States Centers for Disease Control (CDC) health guidelines recommend that all adults should accumulate 30 minutes or more of moderate-intensity physical activity on most days of the week (12).

To determine the prevalence of adults meeting these health-related guidelines, different scoring protocols were applied to physical activity questionnaire data. The first scoring protocol classified a participant as being adequately physically active if they reported an exercise frequency of at least five times per week. The second scoring protocol classified a participant as being adequately physically active if they reported accumulating at least $150 \text{ min}\cdot\text{wk}^{-1}$ of moderate intensity physical activity. Using the first scoring protocol resulted in more than double the number of participants meeting the CDC guidelines for exercise compared with the second protocol. Additionally, if the CDC guideline only includes moderate-intensity activity, then applying these two protocols results in the proportion of participants meeting this guideline ranging from 4 to 17% for the first and 8 to 44% for the second protocol (14). This is a vast difference, which highlights the importance of the standardization of measurement of frequency and duration of physical activity in a scoring protocol.

A concise and thorough physical activity questionnaire should measure the following characteristics;

- a) *type* of physical activity (leisure, occupational, household)
- b) *frequency* of physical activity (average number of sessions per given time frame)
- c) *duration* of physical activity (average number of minutes per session)
- d) a specific *time frame* (usually one day, week, month, or year) and
- e) estimated *intensity* of physical activity (degree of vigor or metabolic cost)(8).

Scoring protocols for physical activity commonly vary by the inclusion or exclusion of frequency data or the range of intensity levels included (14). The two most common estimates for questionnaire data are derived from:

- 1) *Total time* spent in physical activity (frequency x duration).

Time weighted by the estimate of the *intensity* of that activity (total time x average intensity expressed as metabolic cost or METs). One MET represents the approximate rate of oxygen consumption of a seated adult at rest, or about $3.5\text{mL}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$. The equivalent energy cost of 1 MET in $\text{kilocalories}\cdot\text{min}^{-1}$ is about $1.2\text{kcal}\cdot\text{min}^{-1}$ for a 70kg person, or approximately $1\text{ kcal}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$. Once METs have been expressed they can be converted into kilocalories, if the subject's body weight is known (8). There are extensive lists of physical activities and their corresponding MET values, such as the *Compendium of physical activity: classification of energy costs of human physical activity* (1;2), which are available for calculation of estimated energy expenditure in a wide variety of settings. The Compendium (2) has shown to be as accurate as direct heart rate measurement to predict energy expenditure (15).

In summary, it is important to clarify terms and methods used in exercise science to ensure consistency, the ability to articulate and express correctly, clarification and for further research. The choice of terms and methods used often depends upon the research being conducted or the outcome being studied. I have defined terms in physical activity epidemiology, validity and reliability of physical activity questionnaires, as well as measurement expressions used to score physical activity as these terms pertain to this dissertation.

References

1. Ainsworth, B. E., W. L. Haskell, M. C. Whitt, M. L. Irwin, A. M. Swartz, and S. J. Strath. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc. Med Sci Sport Exerc.* 32: S498-S516, 2000.
2. Ainsworth, B. E., W. L. Haskell, A. S. Leon, D. R. Jacobs, Jr., H. J. Montoye, J. F. Sallis, and R. S. Paffenbarger, Jr. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc.* 25: 71-80, 1993.
3. Booth, M., Jones, D., and Ainsworth, B. E. Workshop on the International Standardisation of Physical Activity Assessment for Public Health Purposes.

Methods of assessing the repeatability and validity of self-report measures of physical activity participation: A discussion paper by the International Physical Activity Questionnaire (IPAQ) Executive. 1999.

4. Booth, M. L., N. Owen, A. E. Bauman, and C. J. Gore. Retest reliability of recall measures of leisure-time physical activity in Australian adults. *Int J Epidemiol.* 25: 153-159, 1996.
5. Caspersen, C. J. Physical activity epidemiology: concepts, methods, and applications to exercise science. *Exerc Sport Sci Rev.* 17: 423-473, 1989.
6. Caspersen, C. J., K. E. Powell, and G. M. Christenson. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* 100: 126-131, 1985.
7. Durante, R. and B. E. Ainsworth. The recall of physical activity: using a cognitive model of the question-answering process. *Med Sci Sports Exerc.* 28: 1282-1291, 1996.
8. Fitzgerald, S. J., A. M. Kriska, M. A. Pereira, and M. P. de Courten. Associations among physical activity, television watching, and obesity in adult Pima Indians. *Med Sci Sports Exerc.* 29: 910-915, 1997.

9. Haskell, W. L., M. C. Yee, A. Evans, and P. J. Irby. Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Med Sci Sports Exerc.* 25: 109-115, 1993.
10. Jakicic, J. M., B. A. Polley, and R. R. Wing. Accuracy of self-reported exercise and the relationship with weight loss in overweight women. *Med Sci Sports Exerc.* 30: 634-638, 1998.
11. Martin , E. A. Oxford Concise Medical Dictionary. Fourth Edition., 222. 1996.
Oxford, Oxford University Press.
12. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A recommendation From the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273: 402-407, 1995.
13. Rauh, M. J., M. F. Hovell, C. R. Hofstetter, J. F. Sallis, and A. Gleghorn. Reliability and validity of self-reported physical activity in Latinos. *Int J Epidemiol.* 21: 966-971, 1992.
14. Sarkin, J. A., J. F. Nichols, J. F. Sallis, and K. J. Calfas. Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Med Sci Sports Exerc.* 32: 149-156, 2000.

15. Spurr, G. B. Daily energy expenditure of women by factorial and heart rate methods. *Med Sci Sport Exerc.* 29: 1255-1262, 1997.
16. Thomas, J. R. and Nelson, J. K. Research methods in physical activity. Second Ed. 1990. Human Kinetics.
17. Vincent, W. J. Statistics in Kinesiology. Human Kinetics, Champaign, IL. 1995, 167-182.

CHAPTER ONE

BACKGROUND TO THE STUDY

Components of total energy expenditure include basal metabolic rate, the thermic effect of food, and physical activity. The last component, physical activity, is the most variable component, and is comprised of occupational, transport, household and sport/leisure activities. Valid and appropriate measurement of physical activity is a challenging task, because the relative contribution of each of these components can vary considerably both within and among individuals and populations.

Accurate measurement of physical activity is needed for several reasons: 1) to quantify dose-response relationships between physical activity and health outcomes, 2) to answer questions about the relative merits of vigorous vs. moderate physical activity and 3) to document the physical activity performed in longitudinal training studies (1;2;5;6). However, physical activity questionnaires, which are widely used in epidemiological studies are inherently biased (7) and limited because they are subjective in nature. While subjects can recall vigorous, structured activity with reasonable accuracy, moderate, less salient activities are less reliably reported. This poses a problem to epidemiologists, since there clearly is a wide-spread difference between the health benefits obtained from light, moderate and vigorous intensity physical activity (5).

Compelling scientific evidence has demonstrated that regular participation in physical activity provides important health benefits. As a result, promotion of physical activity has

become recognized as a public health issue. However, when communicating the significance of regular physical activity to the public, it is important to indicate the type, amount and intensity of physical activity that is needed to obtain these health benefits. The majority of adults in industrialized countries do not, however engage in sufficient physical activity for optimal health.

In order for epidemiologists to capture habitual physical activity patterns from the population to assess their current physical activity levels, it is important to be able to accurately assess the quantity and quality of their physical activity. When studying these patterns in large populations, self-report measures are usually used. These rely on the public to be able to a) accurately recall their physical activity and b) accurately distinguish between moderate or vigorous intensity physical activity.

A study by Stephens et al (1985) reviewed physical activity questionnaires used to measure the prevalence of physical activity in various countries (8). Marked differences were noted in the proportions of populations defined as being physically active during leisure time by the rigor of the definition for moderate and vigorous physical activity. Studies with the most rigorous definition of physical activity showed a larger prevalence of inactivity as compared with studies that used less rigorous definitions. This problem clearly highlights the need to standardize such measurement tools.

In 1998, the World Health Organization (WHO) in conjunction with the United States Center for Disease Control (CDC) conducted workshops on the '*Standardization of the*

assessment of physical activity for public health purposes' in Geneva, Switzerland. Representatives from more than 15 countries contributed towards the formulation of an 'International Physical Activity Questionnaire' (IPAQ). This questionnaire was developed as there was a lack of questionnaires designed to be valid in a cross cultural context, validated against some physiological standard which accurately reflected graded levels of habitual physical activity (3;4).

The proposed IPAQ was designed to measure physical activity for public health purposes in a wide variety of settings and to be suitable in a cross-cultural context. These goals could be achieved if the IPAQ was a) short enough for inclusion in national health behavior surveys and b) simple enough to administer to persons with low levels of literacy.

Physical activity is a complex phenomenon which can be difficult to measure, making the validation of physical activity questionnaires very challenging, however they still prove to be the most popular choice of tool in population studies. Ongoing efforts to improve the validity and reliability of the measurement of physical activity by self-report will enable cross-cultural and international comparisons to examine secular trends in physical activity. This aim of this thesis was to validate the International Physical Activity Questionnaire which relies upon the subject to be able to interpret the terminology describing moderate and vigorous physical activity intensity.

References

1. Bassett, D. R. Validity and reliability issues in objective monitoring of physical activity. *Res Q Exerc Sport* 71: 30-36, 2000.
2. Berlin, J. A. and G. A. Colditz. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol.* 132: 612-628, 1990.
3. Blair, S. N., W. L. Haskell, P. Ho, R. S. Paffenbarger, Jr., K. M. Vranizan, J. W. Farquhar, and P. D. Wood. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol.* 122: 794-804, 1985.
4. Haskell, W. L., M. C. Yee, A. Evans, and P. J. Irby. Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Med Sci Sports Exerc.* 25: 109-115, 1993.
5. Paffenbarger, R. S., Jr., A. L. Wing, and R. T. Hyde. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 108: 161-175, 1978.
6. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A recommendation From the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273: 402-407, 1995.

7. Sarkin, J. A., J. F. Nichols, J. F. Sallis, and K. J. Calfas. Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Med Sci Sports Exerc.* 32: 149-156, 2000.
8. Stephens, T., D. R. Jr. Jacobs, and C. C. White. A descriptive epidemiology of leisure time physical activity. *Public Health reports* 100: 147-157, 1985.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This literature review will focus on the importance of accurate measurements of physical activity, as well as the limitations and advantages of the different methods of validity and reliability testing of physical activity questionnaires. The accuracy and the sources of error of physical activity questionnaires will also be reviewed. Finally, the controversial “dose-response” relationship between physical activity and health will be addressed. The aim of this thesis was to establish clarification on the perception of the terms moderate and vigorous, used to describe physical activity intensity, and secondly to validate an international questionnaire which uses these terms.

2.1 PHYSICAL ACTIVITY QUESTIONNAIRES.

2.2.1 Introduction

Physical activity questionnaires can be self-administered by the subject or interview administered by the researcher in person or on the telephone. When quantifying habitual physical activity, the situation in which the physical activity is done is often of interest to the epidemiologist. For example, in some questionnaires, only occupational activity has been of interest such as the Tecumseh Occupational Activity Questionnaire (53), while others have only been concerned with leisure activities such as the Minnesota Leisure Time Activity Questionnaire (35). Some questionnaires, like the MOSPA questionnaire (69) measure physical activity at work, for transport, at home and during leisure-time, while others, such as the Harvard Alumni Survey (58;67) are more specific about

activities and ask about flights of stairs climbed, city blocks walked and sports played. Salmon et al (2000) showed that physical activity questionnaires were more useful in understanding increasing levels of health risks associated with inactivity, when they queried occupational, house-hold and leisure-time activity, as opposed to only occupational activity (72).

When epidemiologists know which areas the population is most active or inactive, as well as their social and physiological characteristics, this makes the development of physical activity promotion strategies possible.

Questionnaires also assess physical activity in different time periods: the previous 24 hours (81), the previous week (47;70), the previous three months (69;77), the previous year (8;42), or even an entire lifetime (43). The specific disease or outcome of the study usually determines which physical activity questions (volume, type, frequency, duration, intensity etc) need to be asked, and in which time frame. For instance, measuring total energy expenditure in low and moderate intensity activities may be appropriate in an obese population. Participation in physical activity, which elicits a “sweat” response, as well as the length and frequency of each session might be asked in a longitudinal study of cardiovascular disease. If osteoporosis was the outcome measure, then questions concerning distant-past levels of weight-bearing exercise may be sufficient, and if non-insulin dependant diabetes mellitus was being studied, perhaps amount of time spent sitting or being sedentary would be assessed.

Through the use of questionnaire results, physical activity intervention also then becomes more specific about the “dose” of physical activity needed to combat disease. Specific activities can be identified by the questionnaire together with frequency and duration, which makes it possible to estimate total energy expenditure, as well as dose-response for physical activity with respect to health risk. This, however, is a widely debated issue at the moment because it is unclear whether only vigorous, moderate or even low intensity activity and total energy expenditure may have the same health benefit, or whether multiple, short bouts compared to single long bouts of physical activity have the same effect. The same questions are asked about the relationship of intensity to the risk-benefit ratio, as well as the issue of whether questionnaires measure absolute or relative intensity. Should epidemiologists be concerned with the volume or the energy expenditure of physical activity? Can physical activity questionnaires conclude on dose-response issues without taking individual differences into account? These questions are discussed later in this chapter.

There are advantages and limitations of physical activity questionnaires compared to other methods of assessment, such as heart rate recording, behavior observation techniques, diaries and logs etc. Questionnaires are relatively inexpensive and are feasible to administer to large or small populations. They are suitable for use in a wide age range and do not modify or affect behavior. For instance, diaries and logs may affect behavior if they are filled out on a daily basis, and therefore will not reflect the habitual physical activity pattern of the individual. However, physical activity questionnaires require information from past physical activity patterns to be recalled which cannot be

altered. Additionally, physical activity questionnaires have a lower respondent burden i.e. there is not a lot of responsibility on the subject to spend copious amounts of time logging activity or monitoring.

The ability of the subject to recall activity accurately may be a limitation however, depending on the recall time frame. Ideally physical activity questionnaires should also be sensitive to change in individual activity patterns over time. It has been established that if habitual physical activity patterns change over three, six or twelve months, these can be detected by activity recall, and therefore physical activity questionnaires can meet the need of monitoring exercise in populations over time (10). Questionnaires may be inappropriate to use on young children, and may be affected by other factors such as subject's education, culture or socio-economic status (this is expanded upon in section 2.4 'Sources of error in physical activity assessment').

One of its biggest limitations is the difficulty to determine validity and reliability of the questionnaire due to inadequate criteria (i.e. an external physiological standard to reflect levels of habitual physical activity). This is a major problem that no "gold standard" exists for the validation of various questionnaires that can be used in large sample population studies (10;32). The methods currently being used to validate questionnaires are discussed below.

2.2.2 Validation methods of physical activity questionnaires.

Validation techniques for physical activity questionnaires include direct and indirect measures. Direct techniques include doubly labeled water, behavioral observation techniques, dairies and logs, energy intake, movement assessment devices and heart rate. Indirect methods of validating physical activity questionnaires include cardio-respiratory fitness, muscular strength and endurance, flexibility, balance measures of fitness, body composition, blood lipid profiles, heart rate and perceived health that reflects patterns of habitual physical activity. These methods will be discussed briefly, including the strengths and limitations of each for validation of physical activity surveys or questionnaires. However, it is difficult to make direct comparisons between validation techniques because of the variability of the questionnaires studied, the different items contributing to the questionnaire's score, the different units of measurement and the population studied and the statistical analysis applied (11). Finally, specific recommendations for measuring the validity of physical activity surveys are tabulated.

2.2.3. Direct methods

a) Doubly labeled Water.

This method, which is potentially applicable in both laboratory and field studies, can be considered the 'gold-standard' for assessing energy expenditure. The technique's expense however, makes it impractical to use in large epidemiological studies. The principle of this method is that a quantity of water enriched with a known concentration of isotopes of hydrogen and oxygen is ingested. Within a few hours, the isotopes distribute in equilibrium with body water. The labeled hydrogen then gradually leaves the

body as water in the form of urine, sweat and water vapor during respiration. The labeled oxygen also leaves the body as water but also as carbon dioxide. Production of carbon dioxide can be calculated from the difference between the removal rates of the two isotopes. Then, by knowing or estimating the respiratory quotient, it is possible to calculate oxygen uptake for the time period from when the isotopes were ingested (65).

The **advantages** of doubly labeled water as summarized by Montoye, H. (1996) (65) and Racette, S. (1995) (53) include:

- The validity for estimating energy expenditure is good. It has an accuracy to about 1-3% and an error of 4-7%.
- This method is equally applicable to children and adults.
- It can measure energy expenditure over a relatively long period of time: 1-3 weeks.
- Samples can be transported long distances to centralized laboratories, without affecting results.
- This method is safe and painless to the subject. It does not alter behavior, requires little effort on the part of the subject and does not hinder the subject during rest or activity.

The **disadvantages** of doubly labeled water as summarized by Montoye, H. (1996) (65) and Racette, S. (1995) (53) include:

- Information is limited to total energy expenditure, with no frequency, intensity, or duration data.
- Labeled oxygen is expensive (US\$500-\$600 per subject which depends on weight of subject).
- High analysis fees due to sophisticated equipment and expertise needed to operate it.
- High cost limits application to a relatively small group of subjects.

- Error is introduced if respiratory quotient is not known precisely because CO₂ production and not O₂ utilization is being measured.

The doubly labeled water technique, because it is the most accurate and precise method of measuring total daily energy expenditure, is often used to validate other assessments of energy expenditure under conditions of daily living (65). For example, Racette, et al (1995) used doubly labeled water to validate the use of heart rate monitoring and seven-day physical activity recall questionnaire for the measurement of total daily energy expenditure in obese women (65). They found that both heart rate monitoring and seven-day physical activity recall provided accurate assessments of total daily energy expenditure compared to doubly labeled water. Advantages of validating heart rate monitoring and seven-day physical activity recall against doubly labeled water is that they provide information regarding physical activity patterns throughout the day which the doubly labeled water method does not. It can therefore be said that they are valuable tools to be used in conjunction with doubly labeled water.

b) Behavioral Observation Technique

The behavioral observation technique is one of the earliest techniques used to assess physical activity. This technique involves an observer recording behavioral patterns while watching a subject. Trained observers record: behavioral information, types of activities, frequency of each activity and time per activity. Estimating the energy cost of each activity and multiplying this by the time allocation provides an estimate of total energy expenditure. The estimate of energy expenditure for each activity is often obtained from the compendium of physical activities (2;3). It should be kept in mind that

the compendium “*may not reflect the exact energy cost of all physical activities*” and “*often the values are merely averages*” (3). Therefore, this technique has inherent errors which need to be considered when the data are analyzed.

In a study by Klesges et al. (1990), the observer training involved memorizing all response categories as well as the operational definitions of each category (40). Baranowski’s four-category method of quantifying physical activity was used: 1) stationary, no limb movement; 2) stationary, limb movement; 3) slow trunk movement, 4) rapid trunk movement (4). Training videotapes were then made, and observers practiced with videotapes as well as practicing observations until they achieved a 0.90 Kappa inter-rater agreement. A Kappa is a measure of agreement corrected for chance agreements, for the assessment of categorical data (80). On 5% of all the assessment occasions, three other trained observers were asked to simultaneously and independently assess subject’s activity levels with the two assigned observers. The average inter-rater coefficient (assigned vs. external observers) was very good, 0.87 Kappa. Judging from the amount of time taken for training observers and the very good inter-rater agreement (> 90% agreement) required, this technique demands a high degree of accuracy, skill and experience.

Some **advantages** of behavioral observation reviewed by Klesges et al. (1990) (40) and Montoye, H. (1996) (53) include:

- It is particularly useful for use in assessing physical activity in small children.

- With training, observers can be quite accurate. Inter-observer reliability ranges from 84.1% by Puhl et al. (1990) (64) to 98% by O'Hara et al. (1989) (56). Puhl et al. used partial time sampling (five one-minute intervals) during five activities on children (3-6 years) and used heart rate and VO_2 as validation criteria. The reliability was (84.1%). O'Hara et al. (1989) also used partial time sampling (one-minute intervals) during four activities on third and fourth grade students. Heart rate was used as validation criteria and the reliability was 95-98%.

Some **disadvantages** of behavioral observation reviewed by Klesges et al. (1990) (40) and Montoye, H. (1996) (53) include:

Subjects may alter their usual activity when they know they are being observed.

- Observing and recording can be tedious and laborious
- Like diaries, the accuracy possibly decreases as the observation period increases. However, various forms and even computer devices have recently become available to make recordings more efficient.
- This method may not be suitable for use in studies involving large groups.
- Observations are confined to relatively short periods of time, and may therefore not accurately reflect habitual physical activity.

c) Diaries and Logs.

Physical activity diaries and logs cost considerably less than doubly labeled water and behavioral observation techniques described above. Although the material cost is low, the subject is required to be committed, as subjects must attend to the diaries continuously

during the study period. Several questionnaires have been validated by using 24-hour diaries (81), 48-hour diaries (68), three-day diaries (47;74), as well as seven-day logs (36) and diaries (14). Diaries may be used intermittently for longer periods, such as the average of three 24 hour diaries used over three weeks in the Modified Baecke Questionnaire validation (81). Logs query specific activities and are administered at specific time periods. This is in contrast with diaries which record all activities throughout the day, which can make them tedious. Studies using physical activity records and diaries to validate physical activity questionnaires have obtained correlation coefficients ranging from $r = 0.33$ (68) to $r = 0.66$ (63).

Advantages of logs/diaries to assess habitual activity include(14;53;68;81;47;74)

- Actual data collection requires little expense.
- No observer is required for data collection.
- Many subjects can collect data simultaneously.
- A list of the actual activities is available for study and provides data to estimate energy expenditure.
- The subject is not prompted by an interviewer, or pressurized to report activity to an interviewer. The subjects fill in their diaries on their own and in their own time.

Disadvantages of logs/ diaries to assess habitual physical activity include (14;47;53;68;74;81):

- Processing large volumes of data can be time consuming and expensive for the researcher.

- Subjects need to be highly conscientious and cooperative for accurate data to be obtained.
- Even if the subject is conscientious, they may forget to log all entries or make recording errors.
- Subjects know that data is being collected, so the process itself may result in a change in habitual activities patterns.
- This method may be inappropriate for children below the age of ten and perhaps even for older or less educated children.
- Logging activities can become tedious, so the longer the period of data collection, the less accurate the results may be.

d) Movement assessment devices.

Pedometers focus on the distance walked, motion sensors count the number of times a limb or the trunk moves, and accelerometers monitor the acceleration of the body during activity (32). However, all of the actual energy expended is not reflected in the acceleration or deceleration of the body mass. In walking, for example, some counterbalancing movements of the limbs that require energy may not contribute to acceleration or deceleration of the body (53).

The major limitations of motion detectors is that they do not identify types of activities performed or movement patterns that do not activate the sensors such as upper body motion, gliding or riding activities and sedentary activities (32). Motion sensors also inaccurately identify increases in energy expenditure due to movement up inclines (hills

or stairs), or increases in energy expenditure due to increases in resistance to movement (weight lifted or resistance on a cycle ergometer), nor do these sensors detect static exercise. Physical activity measured with motion sensors are more accurate when used in more heterogeneous populations for activities that activate the accelerometer and in surveys that reflect the habitual or traditional activities of the population (11).

Single-plane accelerometers (or uni-axial accelerometers e.g. Caltrac portable vertical accelerometer, Muscle Dynamics Fitness Network, Inc., Torrance, CA, U.S.A.) mounted at the waist reflect vertical movement well, but are not very effective when the motion is in other planes. This suggests that a tri-axial accelerometer (or three-dimensional accelerometer e.g. Tritrac-R3D, Professional products, Reining, Madison, WI, U.S.A) estimates energy expenditure more accurately when various kinds of exercises are involved (25;53). A recent study by Eston et al (1998) showed that triaxial accelerometry provided the best assessment of activity for a variety of children's typical activities compared to heart rate monitoring, pedometry and uniaxial accelerometry (25). Oxygen uptake was measured and expressed with body mass raised to the power of 0.75 (scaled oxygen uptake- sVO_2) (25). All measures (i.e. heart rate, pedometry, uniaxial accelerometry and triaxial accelerometry) correlated significantly with sVO_2 ($P < 0.001$). When two measures were used simultaneously, triaxial accelerometry and heart rate predicted sVO_2 better than any measure alone ($R^2 = 0.85$, Standard error of the estimate = $9.7 \text{ ml}\cdot\text{kg}^{-0.75}\cdot\text{min}^{-1}$). However, the best of the single measures was triaxial accelerometry ($R^2 = 0.83$, SEE = $10.3 \text{ ml}\cdot\text{kg}^{-0.75}\cdot\text{min}^{-1}$). This study also showed that pedometers (hip pedometers in particular) in conjunction with heart rate, offer potential

for large population studies and should be considered as a less expensive option compared to triaxial accelerometry.

The cost of motion sensors is comparable to the physical activity record for the same number of subjects. Although the material cost can be high for motion sensors, the demand for time and effort of the subjects and researchers is relatively low (11). Data obtained from motion sensors varies in quality and quantity. The pedometer is the least expensive motion sensor (\pm US\$15) and counts steps taken during activity (5). Among accelerometers, the Caltrac (\pm US\$90) measures only horizontal motion, and does not reflect intermittent activity or provide stored data capability. While the Tritrac-R3D, (Professional products, Reining, Madison, WI, U.S.A) and the CSA (Computer Science and Applications, Inc. Shalimar, FL., U.S.A.) accelerometers (\pm US\$350) do have these features, their cost may prohibit their utility for validation studies (11). Study costs may be reduced when a limited number of motion sensors are purchased and repeatedly used.

A limitation of many of the accelerometers is that they are not designed to be immersed in water and need to be waterproofed to register swimming movements. During cycling, it must be borne in mind that the accelerometer should be worn on a lower limb, and not on the trunk, for greater accuracy to be achieved. If habitual physical activity is to be estimated and day-to-day or seasonal variation is expected in the subject's activity, then various days or seasons should be sampled (14). The number of days needed to reliably

assess physical activity might change once participants in an intervention become more physically active (14).

The Computer Science and Applications, Inc. (CSA), (Shalimar, FL., U.S.A.) activity monitor is a small, lightweight, durable accelerometer that can easily be strapped on to a belt, ankle or wrist (51). An important feature of this activity monitor is the internal real-time clock that allows data to be analyzed over intervals as short as one second. This provides the ability to examine periods of sedentary, moderate and hard activity. The CSA accelerometer has been validated against energy expenditure determined by indirect calorimetry as the criterion measure, as well as being concurrently compared to the Caltrac (Torence, CA, U.S.A) motion sensor (51). Melanson et al. (1994) In this study, physical activity was assessed during treadmill walking and running at different grades. Results showed that CSA (worn on the hip) and Caltrac activity counts were correlated with each other ($r = 0.78$). Correlations of the Caltrac and CSA with energy expenditure measured by indirect calorimetry was $r = 0.82$ vs. $r = 0.80$ respectively; relative VO_2 in $\text{ml} \cdot \text{kg} \cdot \text{min}^{-1}$ was $r = 0.89$ vs. $r = 0.82$; heart rate was $r = 0.76$ vs. $r = 0.66$ and treadmill speed $r = 0.92$ vs. $r = 0.82$ respectively. It was found that both accelerometers were sensitive to changes in treadmill speed, but neither discriminated changes in treadmill grade (51).

It is also possible to define CSA activity count categories for adults that correspond to different activity intensity levels (28). In physical activity epidemiology, researchers are often interested in duration of selected intensity categories that are operationally defined as light, moderate, hard and very hard intensity physical activity. This is now possible

with the CSA model 5032 and 7164 (Shalimar, FL., U.S.A.) (28). For example, a light intensity activity (< 3 MET) would be equivalent to $< 1952 \text{ counts}\cdot\text{min}^{-1}$, a moderate activity (3-6 MET) would be equivalent to $1952\text{--}5724 \text{ counts}\cdot\text{min}^{-1}$, a hard activity (6-9 MET) would be equivalent to $5725\text{--}9498 \text{ counts}\cdot\text{min}^{-1}$ and a very hard activity (>9 MET) would be equivalent to $> 9498 \text{ counts}\cdot\text{min}^{-1}$.

A combination of heart rate and CSA activity count data (51) might provide a more accurate estimate of the quality and quantity of movement which needs to be investigated further. Melanson and Freedson (1995) indicate that for a more accurate prediction of mean energy expenditure, accelerometers should be used in combination on the ankle and hip, as opposed to wearing a single accelerometer on the hip only (51). This obviously raises some logistical concern as it means that researchers will have to purchase double the amount of accelerometers.

e) Heart rate

Heart rate does not measure physical activity directly, but is based on the positive, linear relationship between oxygen uptake and heart rate (32). For example, within-person correlation between heart rate and oxygen uptake during increasing exercise intensity on a motor driven treadmill or cycle ergometer frequently exceeds $r = 0.95$ (13). The widespread use of heart rate monitoring for the prediction of energy expenditure is due to its ease of measurement, the ability to record values over time, and the reflection of the relative stresses placed on the cardiopulmonary system due to physical activity (25).

However, the relationship between heart rate and oxygen consumption varies between individuals (32), and therefore in order to interpret heart rate as an index of physical activity or energy expenditure, it is necessary to calculate the VO_2 –HR relationship for each subject in the study. The results from the study of Haskell et al. (1993) demonstrated that the accuracy of estimating oxygen uptake during a wide range of activities improved when individualized heart rate-oxygen uptake regressions are used (32). Additionally, to obtain a heart rate index that is typical for an individual, it appears to be necessary to obtain data from four to five days of recording (including a weekend day) (53).

While heart rate is associated with energy expenditure at high levels of energy output, the relationship is weaker at lower heart rates (46). However, recent research by Strath et.al. (2000) showed that heart rate was a moderate physiological indicator of VO_2 , and thus energy expenditure, during a wide range of 'lifestyle activities' such as mowing, trimming and gardening. However, after adjusting for age and fitness level, heart rate was a strong predictor of energy expenditure ($r = 0.87$, $\text{SEE} = 0.76$ METs). This finding has important practical significance in large-scale studies (78).

High ambient temperature and humidity, emotion, training status, posture, hydration, and fatigue, may increase heart rate with little effect on oxygen requirement of the work (32). The slope of the relationship between heart rate and oxygen uptake within a person is different for exercise using the arms versus the legs and will vary depending on how much of the activity is static or heavy resistance versus dynamic or low resistance. The

slope of the relationship between heart rate and oxygen uptake also varies between persons depending on their endurance capacity. Thus, just recording heart rate throughout the day has not been generally accepted as an accurate method of assessing physical activity as defined by energy expenditure (27).

Heart rate monitoring has however served as the criterion for assessing validity of self-reports in children (70). Although the authors acknowledged that heart rate was not a perfect criterion for physical activity measures, it was more practical to measure heart rate throughout the day than oxygen consumption in a large sample of children. They studied the validity of the Seven Day Physical Activity Recall (PAR) (71) which is designed to elicit reports of activity of at least 10-15 minutes duration, and of moderate, hard and very hard intensities. At lower heart rate values, both physical activity and psychological variables affect heart rate, but psychological states are unlikely to cause the prolonged heart rate elevations caused by bouts of moderate and vigorous physical activity (70). A correlation coefficient of $r = 0.53$ ($P < 0.001$) for the total group of children ($N = 102$), supported the validity of the PAR.

The “heart rate Flex” method is a method of using heart rate monitoring for estimating energy expenditure which is suitable for many field and epidemiological applications is described by Ceesay et al (1989). In this study, a modified heart rate method of predicting total energy expenditure was cross-validated against whole body calorimetry. Minute-by-minute heart rate was converted to energy expenditure using individual calibration curves when heart rate exceeded a pre-determined ‘FLEX’ value designed to discriminate

periods of activity. (FLEX heart rate was defined as the mean of the highest heart rate during rest and the lowest heart rate during the lightest imposed exercise). Sedentary energy expenditure (below FLEX) was calculated as the mean energy expenditure during lying down, sitting and standing at rest. Calibration curves of oxygen consumption versus heart rate for different postures at rest and during exercise were obtained. The FLEX heart rate method only underestimated total energy expenditure by 1.2 % (6.25 % standard deviation)(n = 20), which was not significant. This method has satisfactory predictive power as has advantages in terms of cost and ease of use.

The use of motion sensors in combination with heart rate recording seems to offer advantages over heart rate recording alone (32;46). It has been found that accuracy of estimating oxygen uptake during a wide range of activities is improved when heart rate and body movements are analyzed simultaneously rather than separately (32). The cost of this method would clearly be prohibitive for many applications, unless multiple systems are developed, or the unit price can be reduced through mass production. This could otherwise make their utility as a validation measure for physical activity limited.

2.2.4 Indirect methods of validation.

Indirect methods of assessing habitual physical activity includes methods such as cardio-respiratory fitness, muscular strength and endurance, flexibility, balance measures of fitness, body composition, lipid profiles and perceived health status. However, these indirect methods do not fall within the scope of this study and therefore will not be discussed.

2.2.5 Summary

All techniques have advantages and limitations. Which technique is chosen to validate a physical activity questionnaire for a study is dependent on the specific characteristics of the technique, the study characteristics itself as well as the surrounding circumstances. No particular technique has proven superior to others in all aspects and research in this area is ongoing. Some considerations when deciding on a validation technique should include:

- the time frame of the study
- the subject burden of the technique,
- the financial budget available (e.g. the technique, data capture or data processing could be costly),
- the information obtained from the validation (e.g. total energy expenditure only versus a breakdown of information on frequency, intensity and duration of physical activity),
- the sample size,
- the accuracy of the technique,
- the potential error (i.e. from the technique or the subject),
- the suitability of the technique according to the age of subjects (e.g. special considerations for children or elderly),
- the practicality and logistics of using the technique in the field,
- the time constraints of data processing (especially important if limited human resources) and finally

- the potential of the subject altering their habitual behavior.
- The generalizability of the data

Table 2.1. summaries the advantages and disadvantages of each validation method as discussed in this chapter.

Table 2.1 Summary of evaluation of field methods of assessing habitual physical activity.

	Observation	Diary	Questionnaire/ interview	Accelerometer	Heart rate	Doubly labeled water
Validity.	Good	Poor to good	Fair	Fair to good	Fair	High
• Average energy expenditure						
• Intensity of energy expenditure	Fair	Poor to good	Fair	Fair	Good	Poor
Reliability*	Good	Unknown	Fair to good	Fair	Fair	Unknown
Size of testing population [#]	Small	Small/large	Small/large	Small/large	Small	Small
Cost	High	Moderate	Low/moderate	Moderate/high	High	Very high
Specific activities	Yes	Yes	Yes	No	No	No
Age group (yr)						
• Children (<13yr)	Yes	No	No	Yes	Yes	Yes
• Adults (20-64yr)	Unknown	Yes	Yes	Yes	Yes	Yes
• Elderly (65+ yr)	Unknown	Yes	Yes	Yes	Yes	Yes
Subject effort	None	Great	Moderate	Little	Little	None
Affects behavior	Yes	Yes	No	Possibly	Possibly	No

*repeatable results on separate occasions.

[#] Small population: < 50. Large population: > 50.

Adapted from Montoye et al (1996) (53)

2.3 SOURCES OF ERROR AND BIAS IN PHYSICAL ACTIVITY ASSESSMENT BY SELF-REPORT/QUESTIONNAIRE

Variables which may affect the accuracy of self-reported levels of physical activity include for example, body composition, gender, age, ethnicity, climate/seasonality, environment, education, socio-economic status, acculturation, physical activity history and attitudes/beliefs/knowledge (22;36;40;65;70;21;41;57;72). These variables need to be identified in order for them to be addressed and accounted for, as far as possible. Durante et al (1996) concluded in their study on the recall of physical activity, that two factors influence the validity and reliability of physical activity self-reports: a) the characteristics of the activity, and b) the characteristics of the respondent. (22). Some of the relevant physiological and non-physiological characteristics of the respondent, cognitive factors of the respondent, and characteristics of the assessment tool are discussed below. Finally, the challenges in measuring physical activity in South Africa are also discussed, as these may contribute to the sources of error in the studies, which follow in this thesis.

2.3.1 Characteristics of the respondent.

Body composition

Klesges et al (1990) found that obesity influences recall accuracy, and obese subjects tend to under-estimate their physical activity levels, while normal-weight subjects over-estimate their physical activity (40). Although, other studies have reported the opposite, that overweight individuals tend to over-estimate or over-report the amount of activity they perform. A study by Jakicic et al (1998), found that approximately 40-60 % of overweight women in a weight loss program over-reported the amount of exercise they

performed (36). This was interpreted as a lack of ability to accurately monitor themselves or, an attempt to mask their inability to achieve an exercise goal. However, Racette et al (1995), found that a combination of heart rate monitoring and the physical activity recall (PAR) questionnaire can accurately assess total daily energy expenditure (TDEE) and energy expended in physical activity in obese women during periods of weight maintenance and weight loss (65). This accuracy was assessed although individual variability was high and subject numbers were low (N=14) due to the use of doubly labeled water . Mean TDEE values, expressed as the % difference from DLW, prior to weight loss were $-5.2 \pm 10.8\%$ by heart rate and $3.4 \pm 14.4\%$ by PAR, and during the diet, $0.9 \pm 14.1\%$ by heart rate and $0.9 \pm 14.7\%$ by PAR. In children, obesity status has not shown to be related to the reliability of recall (70). For example, Sallis et al (1993) found that children with high sum of skinfolds recalled activity more accurately for the Godin-Shepard Survey ($r = 0.91$ vs $r = 0.76$ $P < 0.001$). However, for very hard activities (heart rate >160 bpm) in the PAR, obese children assessed physical activity less accurately ($r = 0.53$ vs $r = 0.64$, $P < 0.001$).

Age and gender

The seven day physical activity recall (PAR) was found to be a valid and reliable method for assessing physical activity in children as young as 10-11 years. However, both reliability and validity improved with age, and realistically, children younger than age 10 years should not be expected to provide usable recalls of their physical activity (70). The same study also found that boys were more reliable reporters of their physical activity than girls. This has also been shown in adults, where females underestimated their

activity levels relative to males (40). Older males tend to overestimate their record of physical activity and younger males tend to underestimate their record of physical activity (22). Younger males tend to provide more reliable responses for non-working days than for working days (22).

Climatic conditions

Climatic conditions can influence the response to a physical activity questionnaire that asks questions regarding participation in activities that induce sweating (57). In hotter conditions, sweating can be independent to the intensity of an activity. A study on 4171 adults in Barcelona showed that the results of a single 'frequency of exercise-induced sweating' question were distorted by variables clearly related to sweating such as ambient temperature and humidity (measured with and without the presence of overweight) (21). This study also found that prevalence of exercise-induced sweating was greater in the hotter months of the year. This could be a source of error if solely using a 'sweat question' for the measurement of physical activity.

Habitual level of physical activity

Evidence suggests that the most divergence in the accuracy of physical activity self-report is observed in those subjects with high levels of reported habitual physical activity (40). It would be expected that subjects who were physically active, would attend more to the activities they participated in and may therefore be more likely to accurately recall their activity information. Questionnaires rely on subjects to accurately recall their physical activity, assuming a) the subject can remember the type and intensity of the

activity and b) quantify the duration and frequency of the activity. However, the precision of subject's recall is questionable.

In one study that compared self-reports of physical activity in 44 young Caucasian adults (mean age = 21.9 ± 6.5 years) against the criterion of actual observation of behavior, subjects were only moderately accurate in recalling their physical activity levels (40). Subjects were lead to an all-purpose, public track and fitness area where they were instructed to engage in whichever activity they desired. Unknown to the subjects, there was a trained observer quantifying their physical activity levels. Subjects were asked to recall their levels of physical activity for the previous hour. The subjects underreported sedentary activities and over-reported aerobic activities by over 300%, despite the fact that they had to recall only one hour of physical activity and that they were queried immediately following the activity period (40).

Memory

It has been reported that children with poorer memory skills (as measured by the Denman test) were more accurate in their physical activity recalls (70). However, the most reasonable conclusion of these data is that the delayed memory skills measured in the Denman test were different from those memory skills required to recall personal experiences after a delay of several days. Similar findings were reported in adults, where habitually active subjects with high memory skills significantly underestimated their activity level (mean = 11.6 points) relative to those with low memory skills (mean = 15.0 points, $P < 0.01$) (40). This discrepancy could have been caused by the tool used to

measure memory. In this study the Wechsler Memory Scale was used to assess memory. This test assesses short-term memory, which may be different from the memory needed to recall activities over an hour later.

The ability to recall specific details about physical activity events may also be clouded by general memories of past participation habits (22). For example, if a respondent walks every Saturday morning and for some reason, failed to do so on the past weekend, and was asked “Did you participate in any moderate activities this weekend?”. Had the respondent forgotten much of what he did on that day, he would reconstruct the weekend by substituting information from memory traces corresponding to general patterns of exercise for this forgotten information. Therefore, in this example, because the respondent usually walks on Saturdays, he may inaccurately report walking during the past weekend (22).

Intensity of physical activity.

Factors that influence the degree of bias in physical activity recall include the interval between the activity in question and the recall episode, the salience of the activities recalled, the social desirability of the responses, the personal characteristics of the respondent, the behavior of the interviewer, and the interviewing techniques used to obtain information (22). It is understandable that vigorous activities, like playing soccer (± 10 METS), tend to be more accurately recalled, since they are most often deliberate, require considerable effort and are clearly defined. However, moderate activities, like food shopping with a grocery cart (± 3.5 METS), can be mundane and routine tasks in

normal activities of daily living. It is more the quantity (duration) of activity which is poorly reported than the intensity of the activity, since physical activity with a high intensity is usually pre-planned or more easily recalled than activity with a lower intensity (70).

The magnitude of the discrepancy between actual and reported physical activity needs to be carefully reviewed. Durante and Ainsworth (1996) expressed concern for the failure to explain or account for more than 45% of the variance reported between recalled information and both direct and indirect measures of physical activity (22). These authors contend that the unaccounted variance was attributable to error in the cognitive operations used in recalling and reporting physical activity. For example, some error may be due to respondents omitting the types of activities that they have done in the past, or their inability to accurately recall the details of a past physical activity, such as the duration of a particular episode.

Perceived exertion.

A person's perception of effort/exertion will determine the way they report the intensity of their physical activity. Perceived exertion is a widely accepted psychological tool used to study human behavior in many physical activity settings. Perceived exertion can be defined as one's subjective rating of the intensity of work being performed (54). Ratings have been devised by Swedish physiologist Gunner Borg, to quantify perceived exertion, which have been found to be associated with heart rate responses (75) and reflect workload and oxygen consumption (55). The task of the exercising subject, using this

technique of assessment, is to assign a numeral to represent the subjective sensation of the amount of work being performed. This has proven to be a valuable tool since the important consideration is frequently not “what the individual is doing” but rather, “what he *thinks* he is doing” (54).

It has been found that subjects are capable of consistently identifying differences in workload by means of Borg’s psychophysical category scale, and that these subjective estimates reflect the actual metabolic cost of the work being performed (54;75). The exception to this generalization is the case where the subject is *neurotic*, *anxious* or *depressed*, since such individuals appear to have difficulty in their perceptual processing of work intensity (30). The same study also found that extroverts tend to underrate work intensity at heavier loads. Although ratings of perceived exertion are not usually used in validation studies for questionnaires, it is helpful to keep the above psychological states and traits in mind as possible sources of error in recall.

2.3.2 Characteristics of the physical activity assessment tool.

Gender and occupation considerations

Studies consistently show that there is a high prevalence of irregular and sedentary behavior among women compared to men (leading some to speculate that women may need less activity than men to obtain optimal health benefits (1;16;72). This, however, may be as a result of physical activity questionnaires failing to capture the frequency,

duration and intensity of physical activities actually performed by women. For example, if only activities related to sports, recreational pursuits and garden activities were reported in the physical activity records in a study by Ainsworth et al (2000)(1), then fewer than 41% of the subjects would have met the CDC/ACSM recommendation (61) to obtain at least 30 minutes/day in moderate activity on most days of the week. However, using all activities recorded in the compendium of physical activities (3), an estimated 87% of subjects met the CDC/ACSM recommendation in that study. This may suggest that women are getting enough moderate intensity activity and in fact it may be that physical activity questionnaires used to measure physical activity among women need to be reevaluated.

Most of the moderate activities that women participate in have been related to cleaning the house, standing and walking at work, caring for children and older adults, and walking for exercise (3;41). Some of these activities, at first glance, appear to be unrelated to the mechanisms associated with increased fitness or even a reduced risk for chronic diseases of living. However, it is not clear how much these activities contribute to total daily energy expenditure. Additionally, if measurement of total physical activity and activity patterns in a population are the purpose of administering a physical activity questionnaire, then it is important to identify the quantity and quality of *all* the behaviors performed.

A major shortcoming of the Third National Health and Nutrition Examination Survey (NHANES III; 1988-1991) was that the measure of inactivity was based upon leisure

time physical activity, with no consideration of occupational activity. Contemporary physical activity questionnaires seem to only assess leisure time physical activity and have moved away from measuring occupational physical activity due to the decline in occupational physical activity observed in many industrialized countries. This may however be flawed in developing countries and lower socio-economic groups, where occupational physical activity contributes significantly to total energy expenditure (particularly in men) (62).

Defining physical activity

A study by Stephens et al (1985) reviewed physical activity questionnaires used to measure the prevalence of physical activity in various countries (76). They noted marked differences in the proportions of populations defined as physically active during leisure time by the rigor of the definition for moderate and vigorous physical activity. Studies with the most rigorous definition of physical activity showed a larger prevalence of inactivity as compared with studies that used less rigorous definitions. This is especially important for women, and emphasizes the fact that physical activity questionnaires need to include (as broadly as possible) household, family care and occupational chores as well as the usual measurement of sports and conditioning activities.

As discussed previously, vigorous activity may exert more of a protective effect on cardiovascular mortality than moderate physical activity, even if the total amount of energy expended is equal (60). Therefore it is important to obtain information on all

dimensions of physical activity, and that physical activity questionnaires have a clear and well-conceptualized definition of the construct of physical activity.

2.3.3 Sources of error in the assessment of physical activity in South Africa.

In addition to the sources of error described above, the following are some potential sources of error in the assessment of physical activity in South Africa. Measuring patterns of physical activity can be challenging to the South African researcher, due to the following reasons:

- a) Cultural perceptions regarding the definition, nature and intensity of physical activity may differ.
- b) Educational and literacy levels vary considerably which may pose a problem especially when interpreting questions and providing answers.
- c) The conceptualization of conventional units of time for persons who are unemployed or from rural environments is unknown.
- d) The large number of different national languages and dialects can cause language barriers and increase the risk of translation errors.
- e) Socio-economic and ethnic backgrounds differ widely and
- f) There is a total lack of culturally specific, language-specific, validated tools for assessing levels of physical activity.

It is unknown to what extent these factors affect the accuracy of physical activity self-report in South Africa. Further research is warranted in this area to gain a better

understanding of potential error in measuring physical activity in a South African population.

2.3.4. Summary of sources of error and bias in physical activity assessment

Sources of error in measuring physical activity include the characteristics of the respondent and the characteristics of the assessment tool used. Factors such as presence of overweight/obesity, gender, age, hot climate, socio-economic status and habitual physical activity all play a role in contributing to error in the assessment of physical activity. Cognitive factors, which may contribute to the accuracy of the assessment of physical activity, include the age of the subject and memory, the intensity of physical activity and the individual's perception of effort during physical activity. The sources of error in the assessment of physical activity arising from the characteristics of the questionnaire include factors such as the inclusion/exclusion of household or occupational physical activity. In South Africa, occupational and household, physical activity is likely to significantly contribute to total physical activity energy expenditure. The definition of physical activity also has an effect on accuracy of self-report.

2.4 PHYSICAL ACTIVITY AND HEALTH

2.4.1 Physical activity patterns and trends in epidemiological studies.

Demographic factors which reflect differences in patterns in habitual physical activity in previous studies include: gender, age, race/ethnicity, occupation, type of physical activity, education, smoking status, income, family aggregation and physical characteristics. Examples of these studies are discussed below.

Socio-economic status

The Third National Health and Nutrition Examination Survey (NHANES III) for the period 1988-1994 examined the prevalence of physical inactivity during leisure time in a national representative sample of 18 825 United States adults aged 20 years and older (15). The results showed that social class was associated with physical inactivity and that nearly one-quarter of US adults were physically inactive, with more women (28%) than men (17%) reporting being inactive in their leisure time. Additionally, inactivity was more common in persons who were less educated, living in households with annual income below 20 000 dollars, and who were retired.

Gender and ethnicity

In another study, Jones et al (1998) found that only a third of US adults met the Centers for Disease Control (CDC) or Surgeon General's recommendation for moderate leisure-time physical activity (38). Men generally have greater total daily energy expenditure than women (18;23;34;62;69). Women, ethnic minorities, adults with lower levels of education and older adults were least active. Randsell et al (1998) also found that African-American or Mexican-American women, over 40 years and women without a college education had the lowest levels of participation in leisure time physical activity compared to white women (66). However, recently published research on the NHANES III (16) found that although African-American and Mexican-American men and women reported lower levels of leisure time activity than Caucasians, this could not be explained by the current indicators of social class (e.g. education, family income, poverty etc.).

Therefore, Crespo et al (2000) concluded that other constructs of social class, such as acculturation, safety, social support and environmental barriers were responsible for this difference, rather than ethnicity per se. (16). Figure 2.1, below, presents the findings of the Third National Health and Nutrition Examination Survey (NHANES III; 1988- 1991) regarding the age-adjusted prevalence of the U.S. population 20 years of age and older, who report not participating in any leisure-time physical activity (16;41). As can be seen in this figure, non-Hispanic white men and women reported more leisure time physical activity than non-Hispanic black or Mexican- American men and women after adjusting for age.

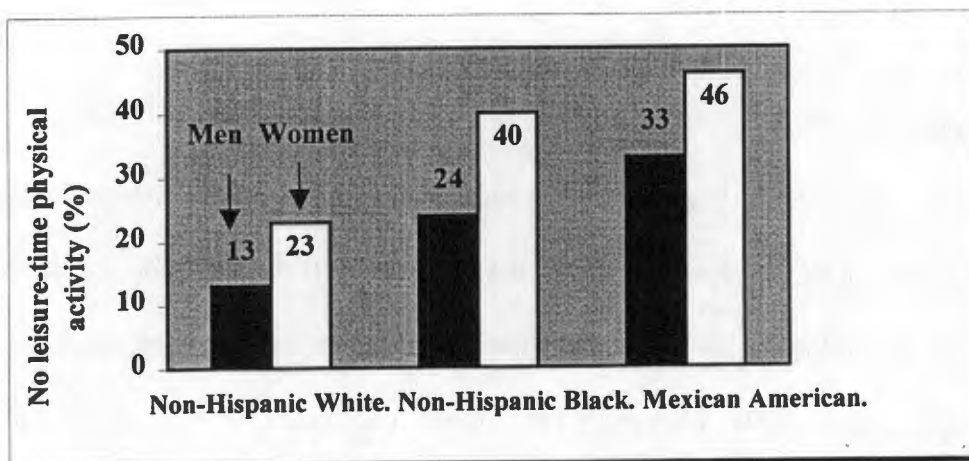


Figure 2.1 Age-adjusted prevalence (per 100) of no leisure-time physical activity of the U.S. population, 20 years of age or older, 1988- 1991.

Modified from Crespo et al. (2000) and Kriska (2000)

Kriska (2000) found that the most frequent types of physical activities performed in many of these minority groups is often low intensity activities (such as walking and housework), which are generally poorly recalled compared to high intensity activities (41). Although “socio-economically disadvantaged” groups (especially “socio-

economically disadvantaged” women) are consistently found to be less active than their majority counterparts, Kriska (2000) believes that these differences could be due to measurement error (41).

Age

Physical activity levels decrease with increasing age, after late adolescence or early adulthood, and continues with larger proportions after age 45-50 (23;39). A study on Dutch men showed that all modes of physical activity, except for walking, decreased with increasing age (8). Older subjects have also shown to perform the same physical activity at higher relative intensities, based on age predicted maximum heart rate, compared to younger subjects (33). A decline in physiological function has also been observed in maximal oxygen uptake, strength and motor neuron loss (17;33). This decline in functional ability with increasing age may be attributable to loss of lean body mass, selective atrophy of type II muscle fibers, motor unit loss, motor neuron loss, early cerebellar dysfunction, loss of flexibility of the joints or a decrease in integrity of the synovial joints (8;17;20;33). The use of age- adjusted absolute MET cut points, or even relative intensity cut points, to account for the effects of age on exercise are discussed later in this chapter.

Physical activity patterns

Walking is often the most frequently observed activity in population studies (23;45;52), and the most prevalent activity reported among all socio-demographic strata in the United States (19). Population studies also show that the majority of energy is spent in low

intensity activities such as walking, cycling and gardening, and that women spend more energy in low intensity activities (8;52). Urban residents also show higher leisure time physical activity compared to rural residents (34). A high prevalence of sedentary behavior in rural areas has been reported. For, example, in a rural county in New York State, 46% of the 29 304 residents were completely sedentary. This finding was based on self- report responses about regular physical activity maintained long enough to work up a sweat (derived from the Paffenbarger questionnaire (57)). However, a limitation of these data is that energy expenditure was calculated from 'sweat frequency', which may have been influenced by fitness level and climatic conditions. Another limitation of this study is that moderate intensity exercise was not considered because it does not elicit the same physiological symptoms of exertion as vigorous intensity exercise, however, the contribution of energy expended during moderate intensity activity is well documented (2;3).

Occupation

Workers with physically demanding occupations are less likely to participate in any leisure-time physical activity compared to white-collared employees (39). However, these blue collared/ manual workers may have equivalent or greater physical activity levels than white collared workers when total physical activity, rather than just leisure time activity is considered (71). This is confirmed by the finding that those subjects with sedentary occupations have a 90 % greater chance of suffering from coronary heart disease (CHD), than those subjects with physically active occupations (7).

Body composition

Overweight subjects did not display lower levels of habitual physical activity than normal-weight subjects, and were therefore no less physically active in a study by Klesges et al (40). However, in a review of the literature, King et al (1992) found that obesity is inversely related to general physical activity levels in a variety of adult populations and obese men and women are less likely to participate in physical activity, even light walking, compared to normal-weight individuals (39).

Health habits

In the same review by King et al (1992), smoking did not show a strong inverse relationship with physical activity levels and family aggregation of physical activity levels only showed modest associations (39). It has been hypothesized that some healthy behaviors cluster together, suggesting that individuals who practice one beneficial health behavior, are likely to practice several beneficial behaviors (18;34;48). There is evidence to support this theory, for instance, leisure-time physical activity and dietary behaviors have been found to be related (48). The WATCH study (48) reported that individuals who participated in at least 30 min·wk⁻¹ of leisure-time physical activity consumed fewer servings of high-fat foods (e.g. meats, sweets, and fried foods), and more servings of micronutrient and fiber-rich foods (e.g. fruits and vegetables). The dietary differences between physically inactive and active subjects remained after controlling for total energy intake, age, gender, smoking, and level of education (48).

A recent study on middle-aged Japanese men and women also found that leisure-time physical activity was positively associated with other healthy behavior (for example, an inclusion of a variety of foods in their diet, a subjective sense of wellness, non-smoking and drinking milk) (34). However, the positive relationship between leisure time physical activity and healthy behaviors has not always been found (18). For example, De Bourdeaudhuij et al (1999) found that people who adhered to a particular healthy habit were not inclined to practice other healthy habits. On the contrary, perhaps one healthy habit was often practiced to compensate for not engaging in other healthy practices, for example people would exercise moderately to compensate for their alcohol intake, poor eating habits and smoking (18).

In summary, reported inactivity seems to be highest in the more vulnerable sectors of the population-i.e. Those of lower socioeconomic status, lower educational attainment, females, older adults (> 45 years), obese/overweight individuals, those with sedentary occupations and rural inhabitants (19). It is still unclear as to whether inactivity is associated with other unhealthy behaviors or ethnic minorities.

2.4.2. Relationship between physical activity and chronic disease of lifestyle: how much is enough?

As reported by Pate et al. (1995), there is a dose-response relationship between physical activity (dose) and the associated health benefits (response) (61). This dose-response relationship indicates that the lower the baseline physical activity status, the greater will

be the health benefit associated with a given increase in physical activity (61). This is illustrated in figure 2.2. However, the issues surrounding "Dose-Response" as they relate to the role of physical activity in the prevention of disease, disability and death, still need to be clarified. The Dose-Response Consensus Statement is currently being examined in order to provide the general public with clear concise physical activity messages, since the quantity of physical activity required to achieve desirable health outcomes is still unclear.

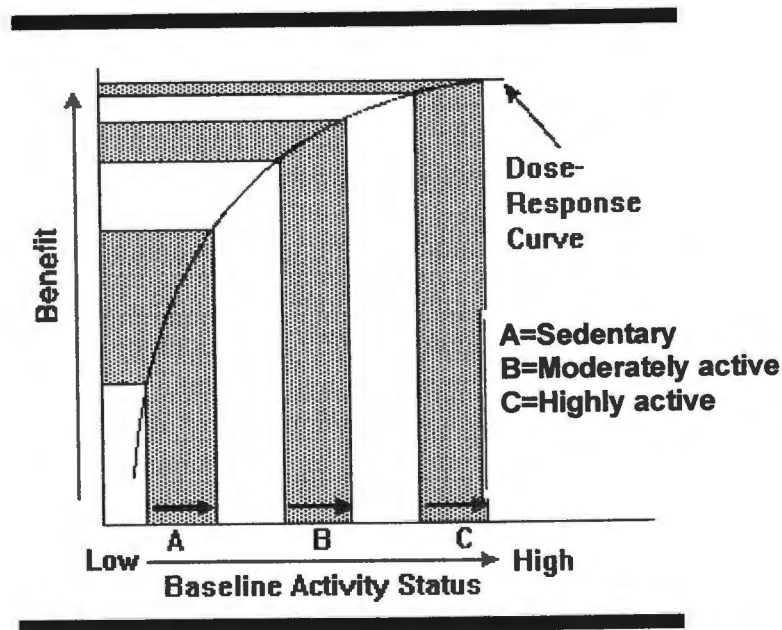


Figure 2.2. The dose-response curve represents the best estimate of the relationship between physical activity and health benefits. The lower the baseline physical activity status, the greater will be the health benefit associated with a given increase in physical activity (arrows A, B and C) Pate et al. 1995 (61).

Interpretation of moderate and vigorous physical activity

Physical activity has shown to be inversely related to the incidence coronary heart disease and mortality in prospective studies (7;9;24;79). It has also been found that methodologically stronger studies tend to show a larger benefit of physical activity than less well-designed studies (7). Additionally, studies have shown that lack of physical activity is a potentially modifiable risk factor for coronary heart disease that should receive greater emphasis in the current efforts to reduce the impact of disease on society (7). The mechanism by which this protection occurs appears in part to be related to a decrease in blood pressure, lower body mass, increase in HDL cholesterol, decrease in total cholesterol/HDL cholesterol and lower prevalence of smoking associated with physical activity (24).

The optimum intensity of physical activity in order to achieve these health benefits remains unclear. Studies on physical activity intensity and morbidity have shown inconsistent findings (8;44;50;52;61). The amount, intensity, and frequency of exercise required for beneficial cardiovascular health changes are outlined in physical activity recommendations (61). These recommendations are based on both population studies and intervention trials, but only a few of these studies have addressed the issue of different intensity levels (especially of low levels), as well as the impact of physical activity for women (52). The same recommendations (61) assign health benefits to moderate levels of physical activity to avoid chronic disease. However, it has also been found that lower levels of physical activity may have beneficial effects on health risk factors, such as CHD (44;52).

Mensink et al (1997) studied the relationships between coronary risk factors and intensity, duration, and frequency of leisure-time activity in nearly 12 000 male and female subjects (25-69 years) (52). Some CHD risk factors showed beneficial associations with moderate and even low intensity activities (such as heart rate, peak expiratory flow and HDL/total cholesterol ratio for moderate activities and BMI, triglycerides and diastolic blood pressure for low intensity activities). In addition, higher frequency and duration of exercise showed, independently of intensity, beneficial associations with risk factors (especially with serum lipids and BMI).

This study is further supported by Lee (2000), whose data showed that the duration of walking, but not walking pace, independently predicted a lower CHD risk in women (44). A practical interpretation of these data are that from a health perspective, time spent walking (duration of activity) was more important than walking pace (intensity). At least an hour of walking per week, regardless of pace, was beneficial for these relatively sedentary women. Furthermore, vigorous activities were associated with lower CHD rates than moderate and light activities in this study (44). However, the subjects in this study were relatively inactive, with the most active group expending $\geq 6\,300 \text{ kJ}\cdot\text{wk}^{-1}$.

Hapaneen et al (1997) found in middle-aged men and women that an increase in total amount of leisure-time physical activity was significantly associated with a reduced risk of CHD. However, an increase in intensity of leisure-time physical activity (and not the total duration of leisure-time physical activity) was associated with a lower risk of hypertension and diabetes (29). These data indicate the relative importance of the total

amount of leisure-time physical activity and intensity may vary depending on the outcome measure.

It is therefore important to accurately distinguish between intensity levels of physical activity, to stratify populations according to risk in epidemiological studies and to determine disease prevalence rates. This may also assist policy makers developing physical activity guidelines or recommendations. For instance, associations of light, moderate, and vigorous intensity physical activity with longevity were reported from a recent reanalysis of the Harvard Alumni Health Study (45). Light activities (< 4 METs) were not associated with reduced mortality rates ($p = 0.72$), moderate activities ($4 - 6$ METs) appeared somewhat beneficial ($p = 0.07$), and vigorous activities (≥ 6 METs) clearly predicted lower mortality rates ($p < 0.001$). These data provide some support for current recommendations that emphasize moderate intensity activity; they also clearly indicate the benefit of vigorous activity.

In another study by Taylor et al (1992), subjects had to report their participation in occupational or leisure-time physical activity as: 1) sedentary; 2) light; 3) moderate; and 4) heavy in order to calculate the cardiovascular disease (CVD) and diabetes prevalence risk profile. Subjects classified as having sedentary or light levels of physical activity had double the rate of diabetes and CVD than those subjects who were classified as having moderate or heavy levels of physical activity (79).

However the difficulty in comparing physical activity studies is that there is lack of agreement in the literature pertaining to energy expenditure cut-off points for the classification of moderate and vigorous activities. For example, a study has described moderate activity as 3-5 METs, hard activity as 5.1 – 6.9 METs, and very hard activity as ≥ 7 METs (10). Whereas another study has described 'sports play' activities as light, requiring < 4.5 METs, and moderately vigorous as ≥ 4.5 METs (59). Yet another study has described light activity as 4 -7 METs, medium heavy as 7-10 METs and heavy as ≥ 10 METs (57).

To further illustrate the inconsistency in the literature, walking as the most common form of exercise (49), may be used as an example. For many people walking represents their major physical activity outside the domain of sedentary living. The specific energy requirements for walking activities differ widely in the literature. For example, walking has ranged from 15 to 25 $\text{kJ}\cdot\text{min}^{-1}$ (3.5 to 6.0 $\text{kcal}\cdot\text{min}^{-1}$) (20;12) and from 3.0 to 6.5 METs (3.6- 7.8 $\text{kcal}\cdot\text{min}^{-1}$ for a 70 kg person) (3;60;61). A differentiation in classification has also been made for walking when it is used as a mode of transport to and from work, for pleasure or recreation, for exercise, or whether walking on a firm surface or walking on a treadmill (2;3;12;20;31;60;61). Ranges of energy expenditure and different intensity classifications associated with walking have been tabulated in **Table 2.2.**

Table 2.2. The different physical activity classifications and energy expenditure of walking used in various questionnaires.

Questionnaire	Activity category	Energy cost	Classification for intensity of activities
Paffenbarger/ Harvard Alumni questionnaire ^a	a) Walking b) Treadmill walking	a) 4.0 METs b) 6.0 METs	Light = ≤ 4 METs Moderate = 4.5- 5.5 METs Vigorous = ≥ 6 METs
Framingham Physical Activity Index ^b	Leisure time physical activity. Walking to work: Walking for pleasure.	 4 kcal·min ⁻¹ (3.5 METs) 3.5 kcal·min ⁻¹ (3 METs)	None specified.
Amsterdam growth Study Questionnaire ^c	Walking	4-7 METs	Light = 4-7 METs Medium-heavy = 7-10 METs Heavy = ≥ 10 METs
Yale Physical Activity Survey ^d	Exercise category: Brisk walking Recreational activities: Leisurely walking:	 6.0 kcal·min ⁻¹ (5 METs) 3.5 kcal·min ⁻¹ (3 METs)	Not specified
Physical Activity Recall Items ^e	Sports activities: Brisk walking for pleasure or to work (4.83 km·h ⁻¹ or 3 mph):	3-5 METs	Moderate activity = 3-5 METs Hard activity = 5.1 – 6.9 METs Very hard activity = ≥ 7 METs
Canada Fitness Survey ^f	Walking for exercise can be Light: Moderate: Heavy:	3.0 METs 4.0 METs 5.0 METs	
Seven Day Physical Activity Recall ^g	Walking at a normal pace: Running:	4 METs 10 METs	Moderate activity = 4 METs Hard activity = 6 METs Very Hard activity = 10 METs Instruction to interviewer: “If an activity is harder than walking at a normal pace, but not as strenuous as running, place it in the hard category (6 METs)”

Table 2.2 continued...

Questionnaire	Activity category	Energy cost	Classification for intensity of activities
Compendium of Physical Activities: classification of energy costs of human physical activities. Ainsworth ^h	Walking -		
	2.5 mph (4 km·h ⁻¹):	3 METs	
	3.5 mph (5.6 km·h ⁻¹):	4 METs	
	4.0 mph (6.4 km·h ⁻¹):	4 METs	
	4.5 mph (7.2 km·h ⁻¹):	4.5 METs	
	Running 5 mph (8 km·h ⁻¹):	8 METs	
Bouchard 3 Day Physical Activity Record ⁱ	Moderate sport/ leisure activities: Brisk walking	4 METs	
The physical activity questionnaires of the Kuopio Ischemic Heart disease study (KIHD) ^j	Conditioning physical activity: Walking.	Subject can select any of these intensity levels: 0 = 3.0 METs 1 = 4.5 METs 2 = 6.0 METs 3 = 7.0 METs	Intensity category: 0 = recreational exercise 1 = conditioning exercise 2 = brisk conditioning exercise 3 = competitive strenuous exercise.
	Physical activity during journeys to work: Walking		

^a From Lee, I.M. (1992) Time trends in physical activity among college alumni, 1962-1988. *Am J Epidemiol.* 108, 161-175.

^b Dannenberg, A.L. & Wilson, P.W.E. (1989) Framingham leisure time physical activity questionnaire. In Dury, T.M. Assessing physical fitness and physical activity in population based surveys, pp650-651. DHHS publication.

^c Kemper, H.C.G. (1995). The Amsterdam growth Study: A longitudinal analysis of health, fitness, and lifestyle, (pp. 42-44). Champaign, IL : Human Kinetics.

^d Di Pietro, L., Caspersen, C.J., Ostfeld, A.M., Nadel, E.R. (1993) A survey for assessing physical activity in older adults. The Yale Physical Activity Questionnaire. *Med Sci Sports Exerc.* 25:628-642, 1993.

^e Sallis, J.F., Haskell, W.L., Wood, P.D., Fortmann, S.P., Rogers, T., Blaire, S.N., Paffenbarger, R.S., Jr. (1985). Physical activity assessment methodology in the five-city project. *Am J Epidemiol.* 121, pp 91-106.

^f Fitness and Lifestyle in Canada. Ottawa: Canada Fitness Survey, 1983. (distributed by the Canadian Fitness and Lifestyle Research Institute).

^g Sallis, J.F., Haskell, W.L., Wood, P.D., Fortmann, S.P., Rogers, T., Blaire, S.N., Paffenbarger, R.S., Jr. (1985). Physical activity assessment methodology in the five-city project. *Am J Epidemiol.* 121, pp 91-106.

^h Ainsworth, B.E., Haskell, W.L., Leon, A.S., Jacobs, D.S et al. (1993). Compendium of Physical Activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc.* Vol 25, No.1 pp 71-80.

ⁱ Bouchard, C.A., Tremblay, C., Le Blanc, G., Lortie, R., Savard, R. A method to assess energy expenditure in children and adults. *Am. J. Clin. Nutr.* 37:461-467, 1983.

^j Lakka, T. Leisure Time Physical Activity, Cardiorespiratory Fitness, Biological Coronary Risk Factors and Coronary Heart Disease: A population Study in Men in Eastern Finland. Academic Doctoral Dissertation. Kuopio University Printing office. Kuopio, Finland, 1994

Table 2.2. illustrates the need to standardize intensity classifications in order to compare studies. For example, the Amsterdam Growth Study Questionnaire classifies light activity as 4 – 7 METs, whereas the Physical Activity Recall classifies a very hard activity as ≥ 7 METs. This variation in classification creates problems when different studies are used to establish guidelines for physical activity, or when different studies are used to establish associations between the risk of disease and physical activity.

Use of absolute cut-points to classify physical activity intensity

The use of absolute cut- points, such as 3 – 6 METs for a moderate activity, may hold limited validity when considering populations of different ages and fitness levels. For instance, 6 METs could be perceived as “light” for a young athlete, but hard for an 80-year old person (78). To account for this problem it is possible to use age- adjusted absolute MET cut points, or even use relative intensity cut points of $< 30\%$ (light), $30 - 60\%$ (moderate), and $> 60\%$ (vigorous) of predicted maximum heart rate or VO_2 . However, it is important to consider that with increased fitness, trained individual’s maximum heart rate and exercising heart rate response changes, which has implications for basing relative intensity on age-predicted maximal heart rate. Age-predicted maximal heart rate is only a prediction, and does not take individual variation or fitness into account (78).

Another concern when comparing physical activity studies is that some questionnaires rely on frequency and/or duration of physical activity only, as opposed to intensity, for calculating protection against poor health or injury (26;37). For example, a population-

based case-control study on physical activity and hip fracture provided a four response option to the question “Do you or did you ever practice sports or physical exercise during leisure time?” (1) Never (2) < 1 hour weekly (3) 1-2 hours weekly and (4) > 2 hours weekly (26). Similarly, a study on change in lifestyle factors and their influence on health status and all-cause mortality categorized leisure time physical activity into five categories ranging from ‘being physically inactive’ or ‘occasionally active’ versus ‘regular physical activity at least once a week’ (37). Neither study requested any information on the intensity of activities performed, but was more concerned with the overall amount of activity achieved. This could have resulted in an underestimation or the lack or detection of the health benefits of physical activity.

Despite these shortcomings in the study design, the abundance of evidence on the benefits of physical activity and dangers of sedentary living, regardless of how they were measured, cannot be ignored. The CDC/ACSM guidelines should continue to be recommended until there are better studies with more accurate data on the frequency or intensity of this guideline.

2.5 SUMMARY OF THE LITERATURE REVIEW

Accurate measurement of physical activity is needed for several reasons: 1) to quantify dose-response relationships between physical activity and health outcomes, 2) to answer questions about the relative merits of vigorous vs. moderate physical activity and 3) to document the physical activity performed in longitudinal training studies (6;7;60;61).

However, physical activity questionnaires, which are widely used in epidemiological studies are inherently biased (73) and limited because they are subjective in nature. While subjects can recall vigorous, structured activity with reasonable accuracy, moderate, less salient activities are less reliably reported. This poses a problem to epidemiologists, since there clearly is a wide-spread difference between the health benefits obtained from light, moderate and vigorous intensity physical activity (60). Additionally, the activity monitor (CSA Inc.) has shown to be an acceptable tool for the validation of physical activity questionnaires. No research has been done on the perception of the terms 'moderate' and 'vigorous' to determine whether they are understood and uniform across gender, age, occupation, education, language and culture in South Africa.

Physical activity is a complex phenomenon which can be difficult to measure, making the validation of physical activity questionnaires very challenging, however they still prove to be the most popular choice of measurement tool in population studies. Major technological advances have occurred within the last 10 years within the field of physical activity monitoring (6), which indicate that future directions for research include the use of combined instruments, such as an accelerometer plus questionnaire. However, there is still ongoing debate amongst researchers over which accelerometer and which physical activity questionnaire is the most accurate and suitable in population studies.

The physical activity patterns of South Africans have not yet been accurately measured. Furthermore, how factors such as education, socio-economic status, gender and culture

impact on their physical activity patterns is not known. There is a lack of a validated assessment tool to measure physical activity in this population, however, the International Physical Activity Questionnaire has aimed to develop a culturally sensitive questionnaire which can be used in populations with a wide variety of educational backgrounds. It has not yet been established whether the International Physical Activity Questionnaire is a valid and reliable measurement tool in South Africa.

2.6 AIM OF THE STUDY

The aim of this thesis was firstly to establish how accurately subjects distinguish between moderate and vigorous intensity levels, using walking as an example of a physical activity and heart rate as an indication of intensity. The effect of age, language, education and gender on the perception of what a moderate and vigorous physical activity constitutes was of primary interest. Once subject's perception of intensity of habitual physical activity was determined, the second aim of this thesis was to determine (with the use of accelerometry as a validation tool) whether the International Physical Activity Questionnaire (IPAQ), designed to measure moderate and vigorous intensity activity, was a valid and reliable physical activity measurement tool in South Africa.

References

1. Ainsworth, B. E. Issues in the assessment of physical activity in women. *Res Q Exerc Sport* 71: 37-42, 2000.

2. Ainsworth, B. E., W. L. Haskell, M. C. Whitt, M. L. Irwin, A. M. Swartz, and S. J. Strath. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc. Med Sci Sport Exerc.* 32: S498-S516, 2000.
3. Ainsworth, B. E., W. L. Haskell, A. S. Leon, D. R. Jacobs, Jr., H. J. Montoye, J. F. Sallis, and R. S. Paffenbarger, Jr. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc.* 25: 71-80, 1993.
4. Baranowski, T. Validity and reliability of self-report measures of physical activity: an information-processing perspective. *Res Q Exerc Sport.* 59: 314-327, 1990.
5. Bassett, D. R. Accuracy of five electronic pedometers for measuring distance walked. *Med Sci Sport Exerc.* 28: 1071-1077, 1996.
6. Bassett, D. R. Validity and reliability issues in objective monitoring of physical activity. *Res Q Exerc Sport.* 71: 30-36, 2000.
7. Berlin, J. A. and G. A. Colditz. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol.* 132: 612-628, 1990.

8. Bijnen, F. C., E. J. Feskens, C. J. Caspersen, N. Nagelkerke, W. L. Mosterd, and D. Kromhout. Baseline and previous physical activity in relation to mortality in elderly men: the Zutphen Elderly Study. *Am J Epidemiol.* 150: 1289-1296, 1999.
9. Bijnen, F. C. H., C. J. Caspersen, and W. L. Mosterd. Physical inactivity as a risk factor for coronary heart disease: a WHO and International Society and Federation of Cardiology position statement. *Bulletin of the World Health Organisation* 72: 1-4, 1994.
10. Blair, S. N., W. L. Haskell, P. Ho, R. S. Paffenbarger, Jr., K. M. Vranizan, J. W. Farquhar, and P. D. Wood. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol.* 122: 794-804, 1985.
11. Booth, M., Jones, D., and Ainsworth, B. E. Workshop on the International Standardization of Physical Activity Assessment for Public Health Purposes. Methods of assessing the repeatability and validity of self-report measures of physical activity participation: A discussion paper by the International Physical Activity Questionnaire (IPAQ) Executive. 1999.
12. Caspersen, C. J., B. P. M. Bloemberg, W. H. M. Saris, R. K. Merritt, and D. Kromhout. The prevalence of self selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen study, 1985. *Am J Epidemiol.* 133: 1078-1092, 1991.

13. Ceesay, S., A. Prentice, K. Day, P. Murgatroyd, and G. Goldberg. The use of heart rate monitoring in the estimation of energy expenditure: a validation study using indirect whole-body calorimetry. *Br J Nutr.* 61: 175-186, 1989.
14. Coleman, K. J. and L. H. Epstein. Application of generalizability theory to measurement of activity in males who are not regularly active: a preliminary report. *Res Q Exerc Sport* 69: 58-63, 1998.
15. Crespo, C. J., B. E. Ainsworth, S. J. Keteyian, G. W. Heath, and E. Smit. Prevalence of physical inactivity and its relation to social class in U.S. adults: results from the Third National Health and Nutrition Examination Survey, 1988-1994. *Med Sci Sports Exerc.* 31: 1821-1827, 1999.
16. Crespo, C. J., R. E. Andersen, O. Carter-Pokras, and B. E. Ainsworth. Race/ethnicity, social class and their relation to physical inactivity during leisure time: results from the Third National Health and Nutrition Examination Survey, 1988-1994. *Am J Prev Med* 2000 18: 46-53, 2000.
17. Cunningham, D. A., P. A. Rechnitzer, M. E. Pearce, and A. P. Donner. Determinants of self-selected walking pace across ages 19 to 66. *J Gerontol.* 37: 560-564, 1982.

18. de Bourdeaudhuij, I and P. van Oost. A cluster-analytical approach toward physical activity and other health related behaviors. *Med Sci Sports Exerc.* 31: 605-612, 1999.
19. DiPietro, L. Physical activity, body weight, and adiposity: an epidemiologic perspective. *Exerc Sport Sci Rev.* 23: 275-303, 1995.
20. DiPietro, L., C. J. Caspersen, A. M. Ostfeld, and E. R. Nadel. A survey for assessing physical activity among older adults. *Med Sci Sports Exerc* 25: 628-642, 1993.
21. Dominguez-Berjon, F., C. Borrell, M. Nebot, and A. Plasencia. Physical activity assessment in population surveys: can it really be simplified? *Int J Epidemiol.* 28: 53-57, 1999.
22. Durante, R. and B. E. Ainsworth. The recall of physical activity: using a cognitive model of the question-answering process. *Med Sci Sports Exerc.* 28: 1282-1291, 1996.
23. Eaton, C. B., A. N. Nafziger, D. S. Strogatz, and T. A. Pearson. Self-Reported Physical Activity in a rural County: A New York County Health Census. *Am J of Public Health* 84: 29-32, 1994.

24. Eaton, C. B., K. L. Lapane, C. E. Garber, A. R. Assaf, T. M. Lasater, and R. A. Carleton. Physical activity, physical fitness, and coronary heart disease risk factors. *Med Sci Sports Exerc.* 27: 340-346, 1995.
25. Eston, R. G., A. V. Rowlands, and D. K. Ingledew. Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *J Appl Physiol* 84: 362-371, 1998.
26. Farahmand, B. Y., P. G. Persson, K. Michaelsson, J. A. Baron, A. Alberts, T. Moradi, and S. Ljunghall. Physical activity and hip fracture: a population-based case-control study. Swedish Hip Fracture Study Group. *Int J Epidemiol.* 29: 308-314, 2000.
27. Freedson, P. S. Field monitoring of physical activity in children. *Pediatr Exerc Sci.* 1: 8-18, 1989.
28. Freedson, P. S., E. Melanson, and J. Sirard. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc.* 30: 777-781, 1998.
29. Haapanen, N., S. Miilunpalo, I. Vuori, P. Oja, and M. Pasanen. Association of Leisure Time Physical Activity with the Risk of Coronary Heart Disease, Hypertension and Diabetes in Middle-Aged men and Women. *Intl J Epidemiolgy* 26: 739-747, 1997.

30. Haghani, H. and R. Marks. Relationship between maximal isometric knee extensor and flexor strength measures, age and walking speed of healthy men and women ages 18-74. *Physio Canada* Winter 2000: 33-38, 2000.
31. Hakim, A. A. and H. Petrovitch. Effects of walking on mortality among non-smoking retired men. *N Engl J Med* 338: 94-99, 2000.
32. Haskell, W. L., M. C. Yee, A. Evans, and P. J. Irby. Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Med Sci Sports Exerc.* 25: 109-115, 1993.
33. Himann, J. E., D. A. Cunningham, P. A. Rechnitzer, and D. H. Paterson. Age-related changes in speed of walking. *Med Sci Sports Exerc.* 20: 161-166, 1988.
34. Iwai, N., N. Yoshiike, S. Saitoh, T. Nose, and H. Tanaka. Leisure-time physical activity and related lifestyle characteristics among middle-aged Japanese. Japan Lifestyle Monitoring Study Group. *Epidemiology* 10: 226-233, 2000.
35. Jacobs, D. R., Jr., B. E. Ainsworth, T. J. Hartman, and A. S. Leon. A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Med Sci Sports Exerc.* 25: 81-91, 1993.

36. Jakicic, J. M., B. A. Polley, and R. R. Wing. Accuracy of self-reported exercise and the relationship with weight loss in overweight women. *Med Sci Sports Exerc.* 30: 634-638, 1998.
37. Johansson, S. E. and J. Sundquist. Change in lifestyle factors and their influence on health status and all-cause mortality. *Int J Epidemiol.* 28: 1073-1080, 1999.
38. Jones, D. A., B. E. Ainsworth, J. B. Croft, C. A. Macera, E. E. Lloyd, and H. R. Yusuf. Moderate leisure-time physical activity: who is meeting the public health recommendations? A national cross-sectional study. *Arch fam med* 7: 285-289, 1998.
39. King, A. C., S. N. Blair, D. E. Bild, R. K. Dishman, P. M. Dubbert, B. H. Marcus, N. B. Oldridge, R. S. Paffenbarger, Jr., K. E. Powell, and K. K. Yeager. Determinants of physical activity and interventions in adults. *Med Sci Sports Exerc.* 24: S221-S236, 1992.
40. Klesges, R. C., L. H. Eck, M. W. Mellon, W. Fulliton, G. W. Somes, and C. L. Hanson. The accuracy of self-reports of physical activity. *Med Sci Sports Exerc.* 22: 690-697, 1990.
41. Kriska, A. Ethnic and cultural issues in assessing physical activity. *Res Q Exer Sport.* 71: 47-53, 2000.

42. Kriska, A. M., W. C. Knowler, R. E. LaPorte, A. L. Drash, R. R. Wing, S. N. Blair, P. H. Bennett, and L. H. Kuller. Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care* 13: 401-411, 1990.
43. Kriska, A. M., R. B. Sandler, J. A. Cauley, R. E. LaPorte, D. L. Hom, and G. Pambianco. The assessment of historical physical activity and its relation to adult bone parameters. *Am J Epidemiol.* 127: 1053-1063, 1988.
44. Lee, I-Min., Rexrode, K. M, Cook, N. R, Manson, J. E., and Buring, J. E. Physical Activity and Coronary Heart Disease in Women. Is "No Pain, No Gain" Passé? *JAMA* 285, 1447-1454. 2001.
45. Lee, I. M. and R. S. Paffenbarger, Jr. Associations of light, moderate, and vigorous intensity physical activity with longevity. The Harvard Alumni Health Study. *Am J Epidemiol.* 151: 293-299, 2000.
46. Luke, A., K. C. Maki, N. Barkey, R. Cooper, and D. McGee. Simultaneous monitoring of heart rate and motion to assess energy expenditure. *Med Sci Sports Exerc.* 29: 144-148, 1997.
47. Matthews, C. E. and P. S. Freedson. Field trial of a three-dimensional activity monitor: comparison with self report. *Med Sci Sports Exerc.* 27: 1071-1078, 1995.

48. Matthews, C. H. Relationship between LTPA and selected dietary variables in the WATCH study. *Med Sci Sport Exerc.* 29: 1199-1207, 1997.
49. McArdle, W., F. Katch, and V. Katch. Energy expenditure of walking on a level surface at different speeds. *Exercise Physiology, energy, nutrition, and human performance.* Williams and Wilkins. 1996, 169.
50. McMurray, R. G., B. E. Ainsworth, J. S. Harrell, T. R. Griggs, and O. D. Williams. Is physical activity or aerobic power more influential on reducing cardiovascular disease risk factors? *Med Sci Sports Exerc.* 30: 1521-1529, 1998.
51. Melanson, E. L., Jr. and P. S. Freedson. Validity of the Computer Science and Applications, Inc. (CSA) activity monitor. *Med Sci Sports Exerc.* 27: 934-940, 1995.
52. Mensink, G. B. Intensity, duration, and frequency of physical activity and cardiac risk factors. *Med Sci Sport Exerc.* 29: 1192-1198, 1997.
53. Montoye, H. J. Measuring physical activity and energy expenditure. Champaign, Illinois, Human Kinetics. 1996.
54. Morgan, W. P. Psychological factors influencing perceived exertion. *Med Sci Sport Exerc.* 5: 97-103, 1973.

55. Noble, B. J., K. F. Metz, K. B. Pandolf, W. C. Bell, E. Cafarelli, and W. E. Sime. Perceived exertion during walking and running-II. *Med Sci Sports Exerc* 5: 116-120, 1973.
56. O'Hara, T. Baranowski, and B. Simons-Mortens. Validity of the observation of children's physical activity. *Res Q Exerc Sport* 60: 41-47, 1989.
57. Paffenbarger, R. S., A. L. Wing, and R. T. Hyde. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 108: 161-175, 1978.
58. Paffenbarger, R. S., Jr., S. N. Blair, I. M. Lee, and R. T. Hyde. Measurement of physical activity to assess health effects in free- living populations. *Med Sci Sports Exerc.* 25: 60-70, 1993.
59. Paffenbarger, R. S., Jr., J. B. Kampert, I. M. Lee, R. T. Hyde, R. W. Leung, and A. L. Wing. Changes in physical activity and other life way patterns influencing longevity. *Med Sci Sports Exerc.* 26: 857-865, 1994.
60. Paffenbarger, R. S., Jr., A. L. Wing, and R. T. Hyde. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 108: 161-175, 1978.
61. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A

- recommendation From the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273: 402-407, 1995.
62. Pereira, M. A., A. M. Kriska, M. L. Joswiak, G. K. Dowse, V. R. Collins, P. Z. Zimmet, H. Gareeboo, P. Chitson, F. Hemraj, and A. Purran. Physical inactivity and glucose intolerance in the multiethnic island of Mauritius. *Med Sci Sports Exerc.* 27: 1626-1634, 1995.
63. Pols, M. A., P. H. Peeters, H. B. Bueno-De-Mesquita, M. C. Ocke, C. A. Wentink, H. C. Kemper, and H. J. Collette. Validity and repeatability of a modified Baecke questionnaire on physical activity. *Int J Epidemiol.* 24: 381-388, 1995.
64. Puhl, J., K. Greaves, M. Hoyt, and T. Baranowski. Children's activity rating scale (CARS): Description and evaluation. *Res Q Exerc Sport.* 61: 26-36, 1989.
65. Racette, S. B., D. A. Schoeller, and R. F. Kushner. Comparison of heart rate and physical activity recall with doubly labeled water in obese women. *Med Sci Sports Exerc.* 27: 126-133, 1995.
66. Ransdell, L. B. and C. L. Wells. Physical activity in urban white, African-American, and Mexican- American women. *Med Sci Sports Exerc.* 30: 1608-1615, 1998.

67. Rauh, M. J., M. F. Hovell, C. R. Hofstetter, J. F. Sallis, and A. Gleghorn.
Reliability and validity of self-reported physical activity in Latinos. *Int J Epidemiol.* 21: 966-971, 1992.
68. Richardson, M. T., B. E. Ainsworth, H. C. Wu, D. R. Jacobs, Jr., and A. S. Leon.
Ability of the Atherosclerosis Risk in Communities (ARIC)/Baecke Questionnaire to assess leisure-time physical activity. *Int J Epidemiol.* 24: 685-693, 1995.
69. Roeykens, J., R. Rogers, R. Meeusen, L. Magnus, J. Borms, and K. de Meirleir.
Validity and reliability in a Flemish population of the WHO-MONICA Optional Study of Physical Activity Questionnaire. *Med Sci Sports Exerc.* 30: 1071-1075, 1998.
70. Sallis, J. F., M. J. Buono, J. J. Roby, F. G. Micale, and J. A. Nelson. Seven-day recall and other physical activity self-reports in children and adolescents. *Med Sci Sports Exerc.* 25: 99-108, 1993.
71. Sallis, J. F., W. L. Haskell, P. D. Wood, S. P. Fortmann, T. Rogers, S. N. Blair, and R. S. Paffenbarger, Jr. Physical activity assessment methodology in the five-city project. *Am J Epidemiol.* 121: 91-106, 1985.
72. Salmon, J., N. Owen, A. Bauman, K. Schmitz, and M. Booth. Leisure-Time, Occupational, and Household Physical Activity among Professional, Skilled and Less-Skilled Workers and Homemakers. *Prev Med* 30: 191-199, 2000.

73. Sarkin, J. A., J. F. Nichols, J. F. Sallis, and K. J. Calfas. Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Med Sci Sports Exerc.* 32: 149-156, 2000.
74. Sirard, J. R., E. L. Melanson, L. Li, and P. S. Freedson. Field evaluation of the Computer Science and Applications, Inc. physical activity monitor. *Med Sci Sports Exerc.* 32: 695-700, 2000.
75. Skinner, J. S. and R. Hustler. The validity and reliability of a rating scale of perceived exertion. *Med Sci Sports Exerc.* 5: 94-96, 1973.
76. Stephens, T., D. R. Jr. Jacobs, and C. C. White. A descriptive epidemiology of leisure time physical activity. *Public Health reports* 100: 147-157, 1985.
77. Stofan, J. R., L. DiPietro, D. Davis, H. W. Kohl, III, and S. N. Blair. Physical activity patterns associated with cardiorespiratory fitness and reduced mortality: the Aerobics Center Longitudinal Study. *Am J Public Health* 88: 1807-1813, 1998.
78. Strath, S. J., A. M. Swartz, D. R. Bassett, W. L. O' Brian, G. A. King, and B. E. Ainsworth. Evaluation of heart rate as a method for assessing moderate intensity physical activity. *Med Sci Sport Exerc.* 32: S456-S470, 2000.

79. Taylor, R., J. Badcock, H. King, K. Pargeter, P. Zimmet, T. Fred, M. Lund, H. Ringrose, F. Bach, and R. L. Wang. Dietary intake, exercise, obesity and noncommunicable disease in rural and urban populations of three Pacific Island countries. *J Am Coll.Nutr.* 11: 283-293, 1992.
80. Vincent, W. J. Statistics in Kinesiology. Human Kinetics, Champaign, IL. 1995, 167-182.
81. Voorrips, L. E. A Physical Activity questionnaire for the elderly. *Med Sci Sport Exerc.* 23: 974-979, 1991.

CHAPTER THREE

SELF-SELECTED MODERATE AND VIGOROUS WALKING PACE AND RELATIVE INTENSITY

ABSTRACT

Self-reported physical activity levels are inversely related to chronic disease risk factors. The strength of this association depends, in part, on quantifying the intensity of activity that may be regarded as 'moderate or vigorous' according to CDC/ACSM recommendations. However, individual and cultural perceptions of relative exercise intensity, age, fitness, height, and habitual levels of activity may confound this association. **Purpose:** i) To examine the individual and group differences in self-selected walking pace corresponding to symptoms used to describe moderate and vigorous intensity and ii) to determine factors that may be associated with these differences. **Methods:** A convenience sample of 102 subjects was recruited (63 women, 39 men). Habitual energy expenditure (EE), predicted maximal oxygen consumption ($\text{VO}_{2\text{max}}$) and body composition were measured. Subjects were asked to walk for 6 min on an indoor track, at a pace they regarded as 'moderate'. After heart rate (HR) returned to pre-exercise levels, this was repeated for 'vigorous' intensity. **Results:** Self-selected moderate walking pace was $5.54 \text{ km}\cdot\text{h}^{-1}$ (95% C.I.: 5.40; 5.69), and corresponded to 58 % age predicted maximal HR (%HRmax) (95% C.I.: 56; 60). Mean self-selected vigorous pace was $7.03 \text{ km}\cdot\text{h}^{-1}$ (95% C.I.: 6.85; 7.20), at 72 %HRmax (95% C.I.: 69; 74). Factors predicting vigorous pace were gender, age, $\text{VO}_{2\text{max}}$, % fat and habitual vigorous EE (adjusted $R^2 = 0.52$). Education, occupation, and habitual moderate EE were not associated with walking speed or intensity. **Conclusion:** These results show that subjects could accurately differentiate absolute and relative walking intensities and understood what was meant by the terms 'moderate' and 'vigorous'. However, absolute pace and relative intensity may vary according to differences in gender, fitness, age, height, body fat % and habitual levels of vigorous activity. **Key words:** physical activity assessment, energy expenditure, walking speed, gender, predicted $\text{VO}_{2\text{max}}$, age, body fat, language.

INTRODUCTION

Physical activity, including walking, has been shown to be inversely associated with a variety of chronic diseases, such as coronary heart disease (CHD)(6;30;46;47), hypertension (12;21;27;35), type 2 diabetes (24;32;36;42), obesity (8;13;15;49), osteoporosis (20;28) and hypercholesterolemia (7;9;17). The intensity at which physical activity is performed may be a more important determinant of disease outcomes for some chronic conditions, whereas, the volume of physical activity (duration x frequency) may be for others. For example, Hapane et al (1997) found in middle-aged men and women that an increase in intensity of physical activity was associated with a lower risk of hypertension and diabetes. However, an increase in the total amount of physical activity was significantly associated with a reduced risk of CHD (21).

The Centers for Disease Control and Prevention and the American College of Sports Medicine (CDC/ACSM) have established guidelines for the “dose” of physical activity that may be regarded as “protective” for these chronic diseases. This includes 30 minutes or more of moderate intensity activity on most, or preferably all, days of the week (41). Moderate intensity has been described as 3- 6 METs (metabolic equivalent), which is the equivalent of brisk walking at three to four mph ($4.8 - 6.4 \text{ km}\cdot\text{h}^{-1}$) or at an energy expenditure of $17- 30 \text{ kJ}\cdot\text{min}^{-1}$ (41). Vigorous intensity has been defined as > 6 METs, or the equivalent of walking $> 6.4 \text{ km}\cdot\text{h}^{-1}$, or as $> 30 \text{ kJ}\cdot\text{min}^{-1}$ (41).

A problem in prescribing specific exercise intensity is the lack of agreement in the literature on the appropriate cut-points for the classification of moderate and vigorous activities, especially regarding walking. For example, various studies have described moderate activity as anything between 3-7 METs and vigorous activities from 4.5 to above 10 METs (9;38;39;44). Walking

itself ranges from 2 to 8 METs in the literature (3;16;41) (2;11;40). This overlapping between categories in numerous studies complicates a) the stratification of populations according to risk of disease and physical activity in epidemiological studies b) the development of physical activity guidelines and c) the determination of physical activity prevalence.

This concern over the interpretation of physical activity intensity is justified, given that studies have shown that the dose-response relationship seen between physical activity and health outcomes, may in fact be dependant on the intensity at which physical activity is performed. For example, in the Nurse's Health Study investigators found that persons reporting a 'brisk' walking pace had a greater reduction in relative risk for type 2 diabetes, than those walking at a 'normal' or 'easy' pace (26). Similarly, in the Harvard Alumni Health Study, (31) light physical activity (< 4 METs) was not associated with reduced mortality rates, whereas moderate physical activity (4-6 METs) appeared somewhat beneficial, and vigorous activity (≥ 6 METs) clearly predicted lower mortality rates. Thus, a better understanding of the interpretation of physical activity intensity may provide additional insights into the dose-response relationship between exercise and health outcomes.

An additional concern regarding the generic "dose" of physical activity prescribed in the health-related guideline (41) is that individual differences are not taken into account. For instance, the "dose" is not altered according to differences in gender, age, language, body composition, current level of fitness or ethnic and genetic variations. The next question is whether exercise prescription from these guidelines should in fact be according to absolute terms, which are independent of an individual's physical capacity (and usually expressed in terms such as speed in $\text{km}\cdot\text{h}^{-1}$, METs, or resistance in Watts), or alternatively, in relative terms, according to the

capacity of the individual (usually expressed as a percentage, such as % max HR, % max VO_2 reserve, or % 1 rep max). For instance, it has been established that the actual energy cost of walking may be influenced by factors such as age, fitness, height, leg length, as well as mechanical efficiency (5;14;25;34;50). Whereas, the relative intensity of walking may be influenced by factors such as: age, fitness, culture, environmental conditions, purpose of walking and gender (10;18;21;33;43) (3;40;41).

To summarize, the intensity issues regarding exercise prescription according to generic guidelines for health related purposes are that a) individual differences are not taken into account, b) the classifications of what constitutes a moderate or vigorous physical activity are unclear, c) there are differences in disease outcome according to the interpretation of intensity, d) it is unclear whether prescribed intensity should be absolute or relative and e) the factors which influence absolute and relative exercise intensity have not been established in this context.

We hypothesized that differences in age, gender, biometrical variables, fitness and cultural/language group may affect the perception of moderate and vigorous walking pace in this urban South African sample, resulting in measurable differences in walking pace, as well as differences in relative exercise intensity (based on % of age-predicted maximal heart rate).

Therefore, the aim of this study was to examine the factors that may influence self-selected absolute and relative exercise intensity during walking in a broad cross-section of men and women. The issue was whether or not, given a verbal cue and symptom-linked definition of exercise intensity, subjects could walk within the parameters established by the CDC/ACSM guidelines (41) representing moderate and vigorous activities. In addition, factors that may

influence differences in walking pace at similar relative intensities were determined to provide insight as to whether the terminology 'moderate' and 'vigorous' are understood and uniform across gender, age, occupation, education, language and culture.

METHODS

Subjects. Subjects were selected from a convenience sample of urban South African men (N = 39) and women (N = 63). The sample included members of a corporate cleaning company (N = 14), two fitness and recreation centers (including administrative staff) (N = 21), a local brewery (N = 8), an investment and an insurance company (N = 23), university maintenance and administrative staff (N = 17) and college students (N = 19). The subjects were between the ages of 20-59 years with varied morphological profiles and fitness levels. The sample included persons with a wide range of educational experiences, as well as a broad range of occupations including blue- and white- collared workers. This study was approved by the Ethics and Research Committee of the Faculty of Medicine of the University of Cape Town. Informed, written consent was obtained from all subjects.

Eligibility requirements for study participation included a) absence of acute illness or undergoing medication for chronic disease and b) age 21- 59 years. Every effort was made to select subjects who represented a broad spectrum of socioeconomic and educational backgrounds. The subject's education often determined their level of employment (e.g an attorney vs. a facility cleaner) and there were 40 different occupations represented in this study.

Experimental protocols: first visit. Body mass and height was measured using a Health-O-Meter balance beam scale (Bridgeview, Illinois, USA) and body mass index (BMI) was

calculated ($\text{BMI} = \text{kg}\cdot\text{m}^{-2}$). Skinfold thicknesses were measured using a Bodycare™ Harpenden caliper (England) at four sites: bicep, triceps, suprailliac and subscapula, and body fat % was estimated using the equation of Durnin and Womersley (19). Maximal oxygen consumption ($\text{VO}_2 \text{ max}$) was predicted from a validated 2-km walking test (UKK Institute, Finland) using gender-specific equations including age, BMI, performance time for the walk and heart rate immediately at the finish (29;37). All walking was done on a 142m indoor, tartan track with the ambient temperature controlled at 22 °Celsius (± 1 °Celsius). The UKK Walk Test has been shown to be valid and reliable in a study sample similar in age, BMI and $\text{VO}_2 \text{ max}$, to the subjects in our study. Intra-class correlation coefficients for test-retest reliability were 0.88 in men and 0.91 in women (29).

Second visit. On a separate occasion, within one week of the first visit, the following submaximal ‘moderate’ and ‘vigorous’ walking pace test was administered: A heart rate monitor (Vantage XL, Polar Electro Oy, Kempele, Finland) was fitted onto the subject and resting pulse recorded after five minutes of sitting. Subjects were shown how to warm up by stretching the muscles of the lower limbs before starting. The subject was then asked to walk around the indoor, 142 m track for six minutes at a pace they perceived as ‘moderate’. Two subjects walked on the track simultaneously, however they started 70 m apart, and were therefore on opposite sides of the track, ensuring that they did not influence each other. The distance they walked in 6 min was then recorded to the nearest meter by a calibrated measuring wheel, and the average speed ($\text{km}\cdot\text{h}^{-1}$) was calculated. The subject’s heart rate was taken as the average over the six minutes walked. They were allowed to rest for ten minutes for their heart rates to return to their pre-exercise level (if this did not occur within ten minutes, the subject was given additional time until their pre-exercise heart rate level was achieved). The subject

was not informed of elapsed time or the distance that he/she had walked. The subject was then asked to walk six minutes at a pace he/she perceived as 'vigorous'.

Outcome variables including moderate and vigorous walking pace and relative intensity expressed as a percentage of age-predicted maximum heart-rate (HRmax%), where:

Relative intensity = (mean heart rate during 6 min of exercise ÷ age-predicted maximum heart rate (220-age)) *100

Questionnaire. The International Physical Activity Questionnaire (IPAQ) was used to estimate habitual levels of moderate and vigorous activity based on frequency, intensity and duration. The IPAQ was interviewer- administered in English and included questions on the habitual activities the subject performed in a 'usual' week. This questionnaire has recently been validated in a cross-country, multi-center study conducted under the auspices of the World Health Organisation and the Centres for Disease Control (Bauman et al, International Physical Activity Questionnaire project report, 2001). The questionnaire includes the measurement of physical activity in four domains: (i) occupational PA; (ii) transportation PA; (iii) household chores- garden/yard work and; (iv) leisure, sport and non-work time PA.

The terminology in the questionnaire used to describe 'vigorous' activity to the subjects was: activity that caused one to be 'out of breath' or "breathless" or to have difficulty in holding a conversation; cause one's heart to 'pound'; or to cause heavy sweating, even on a cold day, equivalent to jogging, chopping trees or digging. 'Moderate' activity was described as: activity that caused one to be 'a little out of breath', 'puff and pant', but still be able to speak; to cause one's heart to beat faster; or to cause light sweating, even on a cold day, equivalent to fast

walking, carrying fire wood or sweeping. The same terminology in the PAQ used to describe the physiological symptoms corresponding to moderate and vigorous PA were used to describe moderate and vigorous walking. For this reason, the subjects were given the same definition as above before they walked on the track to ensure the terms moderate and vigorous were clear.

Moderate activity for the purpose of this study was defined as a walking speed of $4.8\text{--}6.4\text{ km}\cdot\text{h}^{-1}$ (3- 4 mph), corresponding to an energy expenditure between 3-6 METs (41). Vigorous activity was defined as a walking speed greater than $6.4\text{ km}\cdot\text{h}^{-1}$ (>4 mph) corresponding to an energy expenditure of greater than 6 METs. One MET represents the approximate rate of oxygen consumption of a seated adult at rest, or about $3.5\text{ mL}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$. This equates to an energy cost of about $4.2\text{ kJ}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$ ($1\text{ kcal}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$). It may have been preferable to randomize the order of walking at a moderate or vigorous pace, however, the authors felt that the vigorous walk may have resulted in 'fatigue' and interfered with effort perception for the moderate bout.

Statistical methods. STATISTICA software for Windows was used for all analyses, Statsoft, Inc. 1984-1999, Tulsa, OK. All data are presented as means \pm standard deviations. Student's T-tests were used to detect morphological and demographic differences between men and women, with the exception of the physical activity questionnaire data which was compared using the Kruskal Wallis test (Table 3.1). Chi squared analysis was used to determine if there were significant differences in the proportions of men and women in this sample with lower or higher levels of education, or in the various language groups.

To examine self selected walking pace and relative intensity in response to a verbal cue describing moderate or vigorous, subjects were grouped either by language/culture, gender, age

tertiles (20-27, 28-38 and 39-59 years), and education level (less than or equal to 12 years of education, or more than 12 years of education). Analyses of variance were used to compare walking speed and relative intensity for so-called moderate or vigorous pace between men and women, or age groups, language groups or educational levels. % Fat, height and VO_2max were used as covariates when comparing differences in walking pace and relative intensity between men and women. An α value of $P < 0.05$ was used to measure statistical significance. One-way analysis of covariance (ANCOVA) was used to show the effect of education, occupation and language on walking speed (adjusted for age and gender). Where significant differences between groups were found, least squares differences post-hoc analysis was performed. We were not able to establish an order effect, as moderate and vigorous walking were not randomized.

Pearson product-moment correlation analysis was used to determine relationships between walking pace or relative intensity with various explanatory variables such as age, % fat, height, VO_2max . Except for self reported vigorous energy expenditure. These data were not normally distributed and relationships were determined using Spearman's rank order correlations. Simultaneous multiple linear regression analyses were used to examine which demographic and anthropometric variables were predictive of moderate and vigorous pace and relative intensity. No variables were forced into the model and interaction effects were tested. Energy expenditure data were not normally distributed and were, therefore, log transformed before inclusion in multi-variate analysis.

Based on the results of the simple correlational analysis and Chi-square tests, variables were selected for entry into the multivariate analysis of determinants of self-selected moderate and vigorous walking pace. These included: gender, age, height, VO_2max , log of total vigorous energy expenditure and the interaction between VO_2max and vigorous energy expenditure. We

also included language as a categorical variable (English as first language vs English as a second language). Body fat % was not included, as it was highly negatively correlated with VO_2max , and thus, would have introduced multi-collinearity. The analysis was not performed using backward or forward stepwise regression, but rather all variables were entered into the model simultaneously.

Sample size determination. We used Graphpad InStat TM (V2.05, 1990- 1994) to determine the appropriate sample size. If, for example, we wished to detect differences in self-selected walking pace between groups of $0.3 \text{ km}\cdot\text{hr}^{-1}$ with a standard deviation of $0.6 \text{ km}\cdot\text{hr}^{-1}$ we would require 63 subjects per group with a power of 80 % and an alpha level of 0.05. However, if we wanted to detect $0.5 \text{ km}\cdot\text{hr}^{-1}$ differences and $0.7 \text{ km}\cdot\text{hr}^{-1}$ standard deviations- (similar to Himann et al 1988 (25)) we only required 31 per group. This sample size was met in our study.

RESULTS

Subject Characteristics:

Anthropometric, demographic and habitual physical activity characteristics of men and women (Mean \pm SD) are presented in Table 3.1. Height, BMI, % fat and VO_2max were significantly different between men and women. The mean height for this group of men and women was $1.65 \pm 0.09 \text{ m}$, weight was $73.6 \pm 13.1 \text{ kg}$, % fat was $27.4 \pm 9.4 \%$ and VO_2max was $36.2 \pm 12.5 \text{ mlO}_2\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$. Subjects represented four different home language groups, however, all were conversant in English, and had received some schooling in English. Seventy- five percent of subjects had continued to study after high school, either a technical diploma, college certificate or university degree. There were no significant differences between men and women in self-

reported habitual walking at work, for transport, or leisure. Men participated in significantly more vigorous PA than women (2.0 ± 2.4 vs. 0.9 ± 1.7 hrs·wk⁻¹ respectively, $P < 0.01$).

Gender differences for self-selected walking pace:

Mean self-selected moderate walking pace for men and women together was $5.54 \text{ km}\cdot\text{h}^{-1}$ (95% C.I.: 5.40; 5.69), and corresponded to $58 \pm 9 \%$ of age-predicted maximum heart rate (HR_{max}) (95% C.I.: 56.2; 59.7). Mean self-selected vigorous walking pace was $7.03 \text{ km}\cdot\text{h}^{-1}$ (95% C.I.: 6.85; 7.20), at $72 \pm 12 \%$ HR_{max} (95% C.I.: 69.3; 74.0). Gender-specific walking pace and corresponding relative intensities for moderate and vigorous walking are presented in **Table 3.2**.

Analysis of variance showed that when asked to walk at a moderate or vigorous pace, men walked faster, but at a lower relative intensity than women ($P < 0.001$, Figures 1 and 2). After covarying for height, % fat or VO₂max, differences in moderate walking pace were no longer significant between men and women. However, gender differences for vigorous walking pace were still significant ($F = 4.5$, $P < 0.05$). After adjusting for covariates, relative intensity for moderate walking remained significantly lower in men, but relative intensity for vigorous walking did not differ between men and women. Therefore, after adjusting for confounding variables, men and women walked at a similar moderate walking pace, however, women achieved at a higher relative intensity than men. Conversely, men walked at a faster vigorous pace compared to women, despite adjusting for confounding variables, however, they still did not achieve at a higher relative intensity than women.

Table 3.1. Anthropometric, demographic and habitual physical activity characteristics of men and women (Mean \pm SD) (N = 102).

	Men (N = 39)	Women (N = 63)	P-level
Age (yr)	35 \pm 11	35 \pm 11	0.96
Mass (kg)	76.4 \pm 13.0	71.8 \pm 12.9	0.09
Height (m)	1.72 \pm 0.07	1.61 \pm 0.08	0.00***
BMI (kg·m⁻²)	25.8 \pm 3.8	27.9 \pm 5.4	0.03*
% fat	18.8 \pm 7.8	32.6 \pm 5.9	0.00***
Estimated VO₂max (mlO₂·kg⁻¹·min⁻¹)	45.9 \pm 12.2	30.2 \pm 8.3	0.00***
HOME LANGUAGE	Men	Women	P=0.63
English (n=54)	20 (37%)	34 (63%)	
Xhosa (n=29)	12 (41%)	17 (59%)	
Afrikaans (n=14)	4 (29%)	10 (71%)	
Other (n=5)	3 (60%)	2 (40%)	
EDUCATION	Men	Women	P=0.69
12 years or less of education (n=25)	10 (40%)	15 (60%)	
More than 12 years of education (n=77)	29 (38%)	48 (62%)	
HABITUAL EXERCISE (hrs·wk⁻¹)			
Walk at work	1.0 \pm 1.7	1.3 \pm 3.0	0.45
Walk for transport	1.2 \pm 1.5	1.0 \pm 1.6	0.50
Walk for leisure	0.8 \pm 1.3	0.9 \pm 1.4	0.41
Moderate physical activities	9.6 \pm 8.7	10.8 \pm 8.6	0.66
Vigorous physical activities	2.0 \pm 2.4	0.9 \pm 1.7	0.01**

* P < 0.05, ** P < 0.01 and *** P < 0.001 men vs. women

Table 3.2. Walking speed ($\text{km}\cdot\text{hr}^{-1}$) and relative intensity (% age predicted HR max) at a self-selected moderate and vigorous walking pace in men and women.

Variable	Women			Men		
	N	Mean (\pm SD)	95% CI	N	Mean (\pm SD)	95% CI
Walking speed at a self-selected moderate pace ($\text{km}\cdot\text{h}^{-1}$)	63	5.35 ± 0.70	5.18 ; 5.53	39	5.85 ± 0.69	5.62 ; 6.07
Exercise intensity at a self-selected moderate walking pace (% HRmax*)	60	61 ± 8^b	59 ; 63	38	53 ± 7^b	51 ; 55
Walking speed at a self-selected vigorous pace ($\text{km}\cdot\text{h}^{-1}$)	63	6.66 ± 0.71^{abc}	6.48 ; 6.84	39	7.62 ± 0.82^{abc}	7.36 ; 7.89
Exercise intensity at a self-selected vigorous pace (% HRmax*)	62	74 ± 10^a	72 ; 77	37	67 ± 13^a	63 ; 71

*Age predicted maximum heart rate

^a $P < 0.001$ men vs. women (unadjusted)

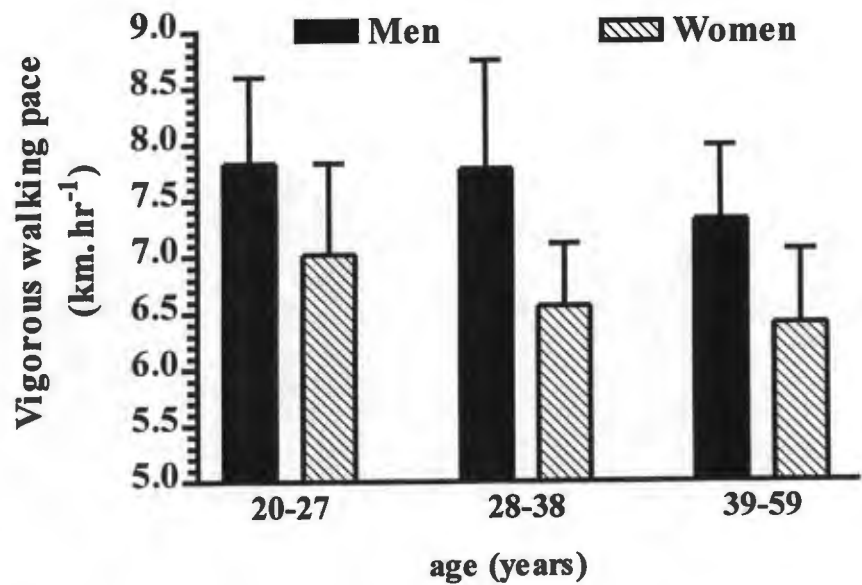
^b $P < 0.01$ men vs. women (adjusted for height)

^c $P < 0.05$ men vs. women (adjusted for height, VO_2max and % fat)

The ACSM guidelines recommend 55–69% of maximum heart rate for moderate intensity PA and 70–89% maximum heart rate for vigorous (or hard) intensity PA (1).

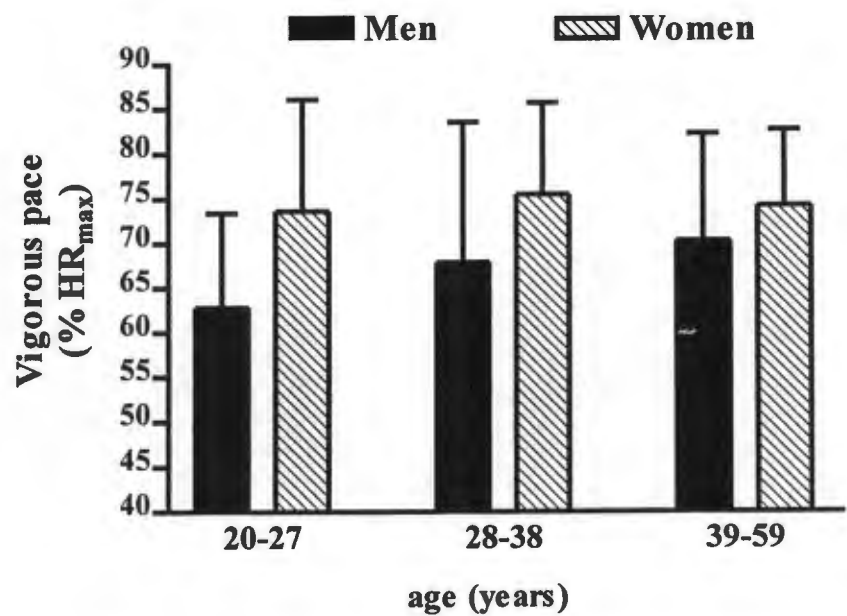
Sample size ranges due to poor tracings of heart rate data.

a.



(Age tertile 20- 27 yr. was significantly different to age tertile 39- 59 yr. for men and women $P < 0.003$)

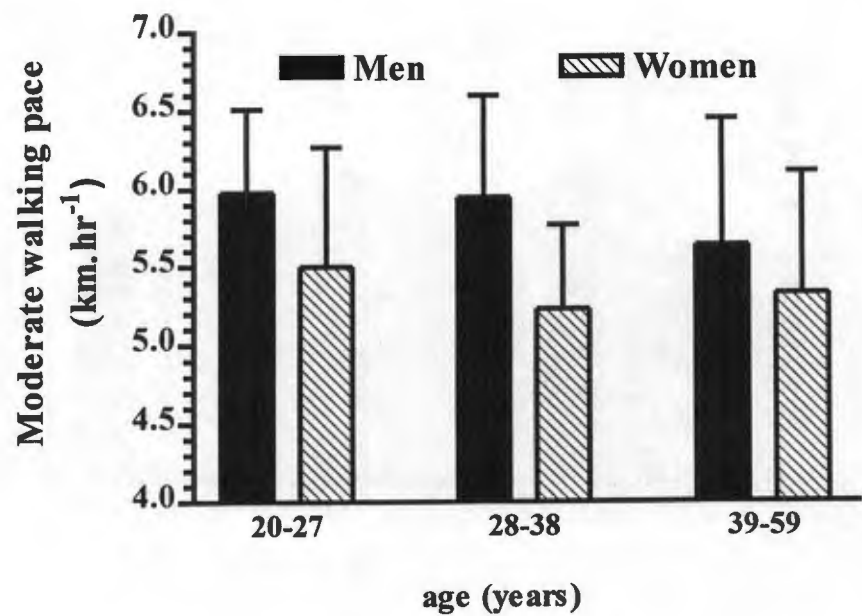
b.



(Women walked at a higher %HR_{max} compared to men, $P < 0.002$)

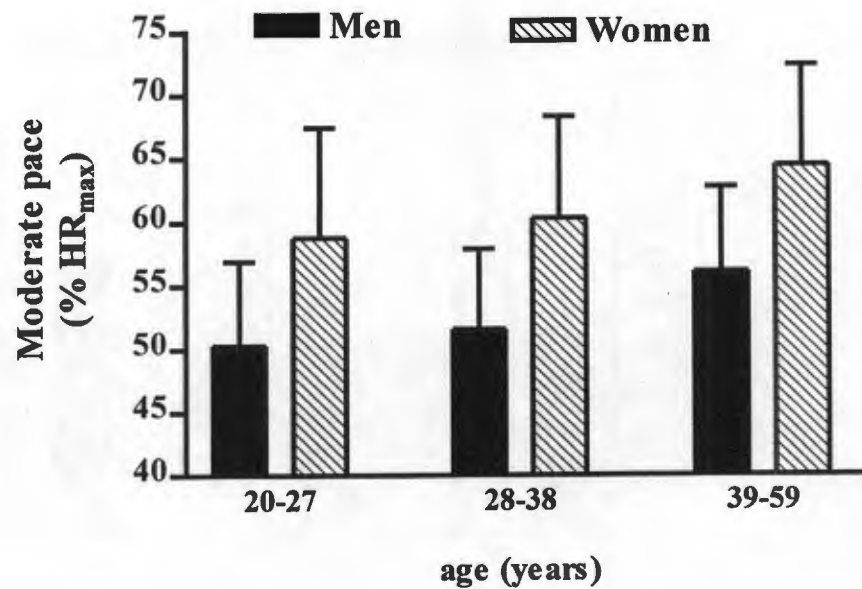
Figure 3.1. Vigorous walking pace (km·hr⁻¹) (a) and relative intensity (% age-predicted HR max) (b): age and gender effects.

a.



(Women walked at a slower moderate walking pace than men, $P < 0.0007$)

b.



(Age tertile 20- 27 yr. was significantly different to age tertile 39- 59 yr for both men and women, $P < 0.004$. Age tertile 28- 38 yr. was significantly different to age tertile 39- 59 yr. for both men and women, $P < 0.025$).

Figure 3.2. Moderate walking pace (km·hr⁻¹) (a) and relative intensity (% age-predicted HR max) (b): age and gender effects.

Table 3.3 shows the percentage of subjects, according to self-selected walking pace, who walked below, within or over the CDC/ACSM recommendations for moderate and vigorous intensity (41) (N = 102). Keeping in mind that moderate intensity is defined by the CDC/ACSM as activity performed at an intensity of three to six METs (work metabolic/resting metabolic rate), the equivalent of brisk walking at three to four mph (4.8 – 6.4 km·h⁻¹) (41). Vigorous intensity is equivalent to six or more METs and walking faster than 6.4 km·h⁻¹. Chi-square analysis demonstrated that a significantly greater number of women walked slower than the 4.8 km·hr⁻¹ moderate recommendation compared to men (24 vs. 8% respectively, $\chi^2 = 6.62$, df = 2, P = 0.037). More men than women walked within the vigorous recommendation (95 vs 60% respectively), ($\chi^2 = 14.78$, df = 1, P < 0.0001). However, it is important to note that 71% and 74% of men and women walked within the range defining moderate and vigorous intensity respectively.

Age related differences in self-selected walking pace and relative intensity:

Relative intensity for moderate walking pace was higher in both men and women in age groups 28-38, and 39-59, when compared to the youngest age tertile (20-27 yrs) (P < 0.02, Figure 2). Vigorous walking pace was faster in the youngest age tertile for both men and women (P < 0.003), however, there were no differences between age groups for relative intensity at a vigorous walking pace. So, considering that the older age groups walked slower than the youngest group, they were still working at a higher relative intensity. The older groups were therefore working harder, even if they were walking slower.

Demographic variables and walking pace and intensity:

There was no effect of education level or occupation on self-selected moderate and vigorous walking pace or relative intensity, after adjusting for gender and age. However, analysis of covariance demonstrated a significant effect of language on moderate walking pace only ($F = 5.9$, $P < 0.01$). Post hoc analysis (LSD test) showed that English-speaking subjects walked at a faster moderate pace than their Xhosa speaking counterparts ($P < 0.001$).

Other factors associated with walking pace and intensity:

Factors associated with self-selected moderate and vigorous walking pace and intensity are presented in **Table 3.4**. Correlational analysis revealed that moderate walking pace was positively associated with height ($P < 0.001$), VO_{2max} ($P < 0.001$) and habitual vigorous energy expenditure ($P < 0.02$), and negatively associated with fat % ($P < 0.001$). Age was not significantly associated with moderate walking pace. Vigorous walking pace was positively associated with height ($P < 0.0001$), VO_{2max} ($P < 0.001$) and amount of habitual vigorous energy expenditure ($P < 0.001$) and was negatively associated with fat % ($P < 0.001$) and age ($P < 0.001$).

Relative intensity of moderate and vigorous walking were both positively associated with % fat and negatively associated with height, VO_{2max} , and vigorous energy expenditure. However, age was positively associated with moderate intensity, but was not associated with vigorous intensity. Correlations between age and weight, age and VO_{2max} , and age and % fat were $r = 0.24$ ($P < 0.05$), $r = -0.34$ ($P < 0.001$) and $r = 0.43$ ($P < 0.001$) respectively. VO_{2max} was negatively correlated to weight and % fat ($r = -0.24$, $P < 0.05$ and $r = -0.86$, $P < 0.001$ respectively). Weight and % fat were positively related ($r = 0.27$, $P < 0.01$).

Table 3.3. Percentage of subjects who walked below, within or over the pace/intensity recommended by the CDC/ACSM^a for moderate and vigorous activities (N = 102).

Self- selected moderate walking pace	Males (%)	Females (%)	Total (%)
Below recommendation (< 4.8 km·h ⁻¹)	8	24	18
Within recommended range (4.8 -6.4 km·h ⁻¹)	74	70	71
Over recommendation (> 6.4 km·h ⁻¹)	18	6	11
Self- selected vigorous walking pace	Males (%)	Females (%)	Total (%)
Under recommendation (< 6.4 km·h ⁻¹)	5	40	26
Within recommended range (> 6.4 km·h ⁻¹)	95	60	74

^a Moderate intensity is defined by the CDC/ACSM as activity performed at an intensity of three to six METs (work metabolic/resting metabolic rate) which the equivalent of brisk walking at three to four mph (4.8 – 6.4 km·h⁻¹) (41). Vigorous intensity is equivalent to six or more METs and walking at least at 6.4 km·h⁻¹.

Table 3.4. Pearson-product moment correlations for factors associated with self-selected walking pace and relative intensity corresponding to “moderate” and “vigorous” activity (n = 102).

	Age	Height	VO ₂ max	% fat	Mod Pace	Mod HR%	Vig Pace	Vig HR%	Log Total Vig EE
Age (yrs)	1.00 -	-0.05 NS	-0.34 P < 0.001	-0.43 P < 0.001	-0.09 NS	0.30 P < 0.001	-0.30 P < 0.002	0.11 NS	-0.18 NS
Height (m)	-	1.00 -	0.55 P < 0.001	-0.50 P < 0.001	0.41 P < 0.001	-0.36 P < 0.001	0.45 P < 0.001	-0.28 P < 0.004	0.35 P < 0.003
VO ₂ max (ml·kg ⁻¹ ·min ⁻¹)	-	-	1.00 -	-0.86 P < 0.001	0.47 P < 0.001	-0.54 P < 0.001	0.68 P < 0.001	-0.33 P < 0.001	0.42 P < 0.001
% fat	-	-	-	1.00 -	-0.37 P < 0.001	0.57 P < 0.001	-0.57 P < 0.001	0.36 P < 0.001	-0.42 P < 0.001
Mod Pace (km·hr ⁻¹)	-	-	-	-	1.00 -	0.01 NS	0.53 P < 0.001	0.00 NS	0.29 P < 0.02
Mod HR% (% age-pred HR _{max})	-	-	-	-	-	1.00 -	-0.24 P < 0.02	0.78 P < 0.001	-0.37 P < 0.002
Vig Pace (km·hr ⁻¹)	-	-	-	-	-	-	1.00 -	0.11 NS	0.42 P < 0.001
Vig HR% (% age-pred HR _{max})	-	-	-	-	-	-	-	1.00 -	-0.34 P < 0.001

MET= Metabolic equivalent task.

EE = Energy expenditure

Simultaneous multiple linear regression analysis

Simultaneous multiple linear regression analysis was used to identify factors that contributed significantly to the variance in both moderate and vigorous walking pace. The original model included the following variables: gender, age, height, language (English first language speakers vs English second language speakers), $VO_2\text{max}$, log of total vigorous energy expenditure and the interaction between $VO_2\text{max}$ and vigorous energy expenditure. Age and language did not contribute significantly to the variance in the model, and were therefore, excluded. Similarly, when the interaction term for vigorous activity and $VO_2\text{max}$ was included, $VO_2\text{max}$ was no longer significant in the model.

Table 3.5a. presents the final model for the analysis of determinants of vigorous walking pace. More than 47% ($SEE = 0.643$) of the adjusted variance in vigorous pace can be attributed to differences in gender and $VO_2\text{max}$. Multiple linear regression analysis for determinants of moderate pace demonstrated that the only variables that contributed significantly to the model were $VO_2\text{max}$ and language. The final model accounted for only 23% of the adjusted variance in self-selected moderate walking pace (**Table 3.5b.** $SEE = 0.645$).

Table 3.5a. Final model for multiple linear regression analysis of factors predicting variance in self-selected vigorous walking pace.

(N = 102)	BETA	Std error of BETA	β	Std error of β	P-level
Intercept			6.12	0.46	0.0001
Gender (M=1, F=2)	-0.18	0.09	-0.33	0.17	0.048
VO₂max (ml.kg⁻¹.min⁻¹)	0.57	0.09	0.04	0.01	0.0001
R = 0.69, R ² = 0.48, Adjusted R ² = 0.47, Standard error of the estimate = 0.64 km. ⁻¹ , F (2, 99) = 45.939, P < 0.0000.					

Table 3.5b. Final model for multiple linear regression analysis of factors predicting variance in self-selected moderate walking pace.

(N = 102)	BETA	Std error of BETA	β	Std error of β	P-level
Intercept			5.16	0.28	0.0001
VO ₂ max (ml.kg ⁻¹ .min ⁻¹)	0.44	0.09	0.03	0.01	0.0002
English as a second language (ESL)	-0.26	0.09	-0.04	0.13	0.003
R = 0.53, R ² = 0.29, Adjusted R ² = 0.27, Standard error of the estimate = 0.63 km. ⁻¹ , F (2, 99) = 19.77, P < 0.0001.					

DISCUSSION

The first finding of the present study was that individuals, from different cultures, living in an urban setting were able to differentiate between a moderate and vigorous walking pace. The mean moderate walking pace was $5.54 \text{ km}\cdot\text{h}^{-1}$, which is equivalent to an intensity of 3-6 METs and falls within the existing criteria for a moderate walking pace ($4.8 - 6.4 \text{ km}\cdot\text{h}^{-1}$ or 3-4 mph) (41). The mean vigorous walking pace was $7.03 \text{ km}\cdot\text{h}^{-1}$ (4.4 mph) which is equivalent to an intensity of > 6 METs (4) or vigorous intensity (41). The mean walking pace for men and women for moderate and vigorous activity corresponded to a relative intensity of $58 \pm 9 \%$ and $72 \pm 12 \%$ of age predicted maximum heart rate respectively. These met the CDC/ACSM guidelines that suggest a moderate intensity activity should correspond to 55–69% of maximum heart rate, and a vigorous intensity activity correspond to 70-89% of maximum heart rate (1). Therefore when prescribing exercise, it would seem acceptable from these results to use these descriptions of moderate and vigorous intensity, in order for individuals to respond with the appropriate exercise intensity.

However, the use of absolute cut- points in physical activity guidelines, such as 3 – 6 METs for a moderate activity, may hold limited validity when considering populations of different ages and fitness levels. For instance, 6 METs could be perceived as “light” for a young athlete, but “hard” for an 80- year old person. To account for this problem it is possible to use age- adjusted absolute MET cut points, or even use relative intensity cut points (48). As hypothesized, differences in gender, culture, age, fitness, body fatness, height and habitual physical activity were found to affect walking pace and relative

intensity in this study. These factors, as well the direction and magnitude of their relationship with walking speed and relative intensity, can be seen in **Table 3.6**. The practical implications of these factors on exercise prescription can be, for instance, the finding that amount of habitual vigorous physical activity, and not habitual moderate physical activity affected walking pace and relative intensity, therefore, when prescribing exercise, subjects with higher habitual vigorous energy expenditure are likely to walk faster, but at a lower relative intensity. From **Table 3.6**. it is also evident that relative intensity of vigorous walking is influenced by fewer of these variables ($n = 5$) compared to relative intensity of moderate walking ($n = 8$). Relative vigorous exercise intensity is not influenced by age, language, gender, moderate or vigorous walking pace and therefore may be a good platform to base relative exercise intensity in on. Moderate walking pace, however, was influenced by fewer variables ($n = 6$), compared to vigorous walking pace ($n = 8$) and may therefore be an appropriate platform to base absolute exercise intensity on.

Table 3.6. Summary of factors which influence walking pace and relative intensity.

Factors	Moderate walking pace (absolute)	Moderate intensity (relative)	Vigorous walking pace (absolute)	Vigorous intensity (relative)
Age		√ +	√ -	
% fat	√ -	√ ++	√ --	√ +
Height	√ +	√ --	√ +	√ -
VO ₂ max	√ +	√ --	√ ++	√ -
Log total vigorous energy expenditure	√ +	√ -	√ +	√ -
Moderate walking pace (absolute)			√ ++	
Moderate intensity (relative)			√ -	√ ++
Vigorous walking pace (absolute)	√ ++	√ -		
Vigorous intensity (relative)		√ ++		
Language	√ - (ESL)			
Gender (after covarying)		√ - (men)	√ + (men)	
√ = significant relationship exists $P < 0.05$ + or - indicates the direction of relationship ++ or -- indicates magnitude of relationship is ≥ 0.50 ESL = English second language				

In our study we used walking as an example of physical activity, as it is the most common form of exercise (34) and for many people walking represents their major physical activity outside the domain of sedentary living. The energy requirements for walking also ranges from 3.0 to 6.5 METs (3;16;41) (11;40) which categorizes it as either a moderate or vigorous physical activity. The possibility of translating our findings on walking to other physical activities remains to be tested. Additionally, the subjects in this study were only asked to walk for six minutes, and it is unclear if they would have maintained the same walking pace and relative intensity had they been asked to walk for a longer period such as 30 minutes.

Gender differences in walking

Although as a group, the subjects were able to differentiate intensity and walking pace, there were specific sub-group differences in walking pace and relative intensity. When analyzed separately, men, walked at a significantly faster moderate and vigorous walking pace and lower relative intensity compared to women. Additionally, men walked below the intensity recommended by the CDC/ACSM for both moderate and vigorous activities by 2-3 % (Comparison seen in **Table 3.2**). These gender differences may relate in part to differences in fitness, % fat, amount of habitual vigorous physical activity and height observed between men and women, because after adjusting for these factors gender differences did not always remain significant.

To expand further on gender differences, we examined factors that may be associated with the accuracy of perception of effort. Simple correlation analysis revealed that the

subjects with the higher VO_2max walked significantly faster and at a lower relative intensity for both moderate and vigorous walking than subjects with a lower VO_2max . Men in our study had a significantly higher VO_2max than women ($P < 0.001$).

Women in our study had a significantly higher % fat ($P < 0.001$) compared to men. This could increase the energy cost of walking due to body fat acting as an additional carried load. In a similar study, Bassey et al (5) reported that % fat was the most influential single factor affecting heart rate during self-paced walking in 277 healthy male and female subjects, and that percentage fat accounted for 23 % of the variance in heart rate. This could explain in part, the differences in relative intensity between men and women.

Height and speed of walking

A significant correlation was also observed in our study between the subject's height and speed of walking. Other studies have also found that height is a significant factor affecting freely chosen walking speeds (5;22;25). This relationship is not surprising, as walking speed is determined by stride length and step frequency, which in turn is associated with height (leg length). Again, after adjusting for differences in height, gender differences for moderate walking pace were no longer significant.

Age and self- selected walking

Subject's vigorous walking pace was significantly slower with increasing age. These results correspond to other research in this field (5;14;22). It is uncertain why no significant relationship between age and moderate walking pace was found in our study.

Bassey et al (5) reported that age did not make a significant contribution to heart rate during walking. In our study, this was true for vigorous walking where there was no significant relationship between relative intensity and age. However, older subjects walked at a greater relative intensity for moderate pace. This finding has been observed in a study by Himann et al (1988), where self-paced walking was used as a measure of the neuromuscular slowing observed with aging (25). Male and female subjects (N = 438; 19-102 yr.) were asked to walk at three self-selected paces (slow, normal, and fast). Older persons walked at a higher relative intensity based on age-predicted maximum heart rate than the younger subjects, and age accounted for 19 to 38% of the variance in relative intensity (25). In our study, only 6 % of the variance in vigorous walking pace could be attributed to age ($r = -0.24$, $P < 0.02$).

Effect of fitness on walking pace and intensity

It is interesting to note that $VO_2\text{max}$ alone accounted for more of the variation in moderate and vigorous walking pace than any other single factor (37 % and 45 % respectively). Time spent in self-reported vigorous activity (in $\text{MET h}\cdot\text{wk}^{-1}$ according to their physical activity questionnaire results), was also associated with increased moderate and vigorous walking pace. Those who participated in more habitual vigorous physical activity also walked at a lower relative intensity. These differences in walking speed could be explained by increased cardiovascular fitness, an age-related regular participation in physical activity or even familiarity with vigorous exercise. Cunningham et al (1982) found that speed of self-selected walking was associated with maximum aerobic power independent of age (14). However Cunningham states that it was unclear

whether “the subjects with high cardiovascular fitness were capable of walking fast, and therefore perform lower intensity walking with more vigor than the subjects with lower levels of cardiovascular fitness, or if the speed of self-paced walking was more directly related to the perception of speed relative to a different scale based on the individual’s maximal aerobic power”. This could be the case in our study.

Demographic and cultural effects on walking.

Occupation and education did not influence self-selected walking speed or relative intensity. However, one of the limitations of our study might be the inability to generalize to uneducated or less educated samples (75% of the subjects had obtained 12 years or more of formal education). This study may have also been limited by a relatively small sample (N = 102), considering that age, gender, language, education and occupation were of interest. Some studies have found significant effects of education level and occupation on the measurement of moderate and vigorous physical activity using recall methods such as questionnaires (10;45). The strength of the association between self-reported physical activity levels and chronic disease risk factors depends in part, on quantifying the intensity of activity that may be regarded as moderate or vigorous. This can be impacted by factors such as individual and cultural perceptions of relative exercise intensity. However, the determinants of physical activity recall are complex, and not within the scope of this study.

Language, social desirability and cultural effects on walking

It is not clear why there was a significant difference between Xhosa- and English-speaking subjects for moderate, but not vigorous walking pace. The authors suspect that this may be due to a cultural effect. The Xhosa- speaking subjects, largely originating from previously socio- economically disadvantaged backgrounds, might be more reliant on walking as a means of transport on a daily basis, which may in some way, affect their perception of effort or result in a more energy- sparing conservative pace.

When subjects were asked to walk, the purpose of walking was not specified, for example they were not told specifically to walk at a pace they would walk to and from work, or walk for exercise, walk for shopping or walk for leisure. This may have been a limitation of this study, as the purpose of walking has been recognized as an important factor in determining the relative and absolute intensity of walking (2;3;11;16;23;40;41).

SUMMARY

In summary, the subjects in this study self selected moderate and vigorous walking paces corresponding with moderate and vigorous intensities in line with CDC/ACSM recommendations. This was in response to standardized verbal instructions and descriptions of symptoms. However, absolute pace and relative intensity may vary according to differences in gender, fitness, age, height, body composition and habitual levels of vigorous activity. **Table 3.6.** summarizes the specific factors which influence the absolute and relative intensity of walking, as well the direction and magnitude of the relationship. The data in this study suggests that exercise prescription is likely to reflect

relative physical activity intensity that may be affected by the factors mentioned above. This study was limited by a small sample size and therefore the results cannot be used to determine the extent to which these factors would affect exercise intensity in larger populations. However, these significant factors warrant further research in order that physical activity guidelines can be established taking these individual differences into account.

References

1. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc.* 30: 975-991, 1998.
2. Ainsworth, B. E., W. L. Haskell, M. C. Whitt, M. L. Irwin, A. M. Swartz, and S. J. Strath. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc. Med Sci Sport Exerc.* 32: S498-S516, 2000.
3. Ainsworth, B. E., W. L. Haskell, A. S. Leon, D. R. Jacobs, Jr., H. J. Montoye, J. F. Sallis, and R. S. Paffenbarger, Jr. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc.* 25: 71-80, 1993.

4. Balogun, J. A., D. A. Martin, and M. A. Clendenin. Human energy expenditure during level walking on a treadmill at speeds of 54-130 m min⁻¹. *Int Disabil Stud.* 11: 71-74, 1989.
5. Bassey, E. J., I. A. Macdonald, and J. M. Patrick. Factors affecting the heart rate during self-paced walking. *Eur J Appl Physiol* 48: 105-115, 1982.
6. Berlin, J. A. and G. A. Colditz. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol.* 132: 612-628, 1990.
7. Bijnen, F. C. H., C. J. Caspersen, and W. L. Mosterd. Physical inactivity as a risk factor for coronary heart disease: a WHO and International Society and Federation of Cardiology position statement. *Bulletin of the World Health Organisation* 72: 1-4, 1994.
8. Blair, S. N. and S. Brodney. Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Med Sci Sports Exerc.* 31: S646-S662, 1999.
9. Blair, S. N., W. L. Haskell, P. Ho, R. S. Paffenbarger, Jr., K. M. Vranizan, J. W. Farquhar, and P. D. Wood. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol.* 122: 794-804, 1985.

10. Booth, M. I. Assessment of physical activity: an international perspective. *Res Q Exerc Sport* 71: S114-S120, 2000.
11. Caspersen, C. J., B. P. M. Bloemberg, W. H. M. Saris, R. K. Merritt, and D. Kromhout. The prevalence of self selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen study, 1985. *Am J Epidemiol.* 133: 1078-1092, 1991.
12. Charlton, K. E., E. V. Lambert, and J. Kreft. Physical activity, change in blood pressure and predictors of mortality in older South Africans-a 2-year follow-up study. *S Afr Med J* 87: 1124-1130, 1997.
13. Colditz, G. A. Economic costs of obesity and inactivity. *Med Sci Sports Exerc.* 31: S663-S667, 1999.
14. Cunningham, D. A., P. A. Rechnitzer, M. E. Pearce, and A. P. Donner. Determinants of self-selected walking pace across ages 19 to 66. *J Gerontol.* 37: 560-564, 1982.
15. DiPietro, L. Physical activity, body weight, and adiposity: an epidemiologic perspective. *Exerc Sport Sci Rev.* 23: 275-303, 1995.

16. DiPietro, L., C. J. Caspersen, A. M. Ostfeld, and E. R. Nadel. A survey for assessing physical activity among older adults. *Med Sci Sports Exerc* 25: 628-642, 1993.
17. Dowse, G. K., H. Gareeboo, M. M. Alberti, P. Z. Zimmet, J. Tuomilehto, A. Purran, D. Fareed, P. Chitson, V. R. Collins, and F. Hemraj. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. *Brit Medical J* 311: 1255-1259, 1995.
18. Dowse, G. K., P. Z. Zimmet, H. Gareeboo, K. George, M. M. Alberti, J. Tuomilehto, C. F. Finch, P. Chitson, and H. Tulsidas. Abdominal obesity and physical inactivity as risk factors for NIDDM and impaired glucose tolerance in Indian, Creole, and Chinese Mauritians. *Diabetes Care* 14: 271-282, 1991.
19. Durnin, J. and V. Rahaman. The assessment of the amount of fat in the human body from measurements on 481 men and women aged 16-72 years. *Brit J Nutr* 32: 77-97, 1974.
20. Farahmand, B. Y., P. G. Persson, K. Michaelsson, J. A. Baron, A. Alberts, T. Moradi, and S. Ljunghall. Physical activity and hip fracture: a population-based case-control study. Swedish Hip Fracture Study Group. *Int J Epidemiol* 29: 308-314, 2000.

21. Haapanen, N., S. Miilunpalo, I. Vuori, P. Oja, and M. Pasanen. Association of Leisure Time Physical Activity with the Risk of Coronary Heart Disease, Hypertension and Diabetes in Middle-Aged men and Women. *Int J Epidemiol* 26: 739-747, 1997.
22. Haghani, H. and R. Marks. Relationship between maximal isometric knee extensor and flexor strength measures, age and walking speed of healthy men and women ages 18-74. *Physio Canada* Winter 2000: 33-38, 2000.
23. Hakim, A. A. and H. Petrovitch. Effects of walking on mortality among non-smoking retired men. *N Engl J Med* 338: 94-99, 2000.
24. Helmrigh, S. P., D. R. Ragland, R. W. Leung, and R. S. Paffenbarger, Jr. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 325: 147-152, 1991.
25. Himann, J. E., D. A. Cunningham, P. A. Rechnitzer, and D. H. Paterson. Age-related changes in speed of walking. *Med Sci Sports Exerc* 20: 161-166, 1988.
26. Hu, F. B., R. J. Sigal, J. W. Rich- Edwards, G. A. Colditz, and C. G. Solomon. Walking compared with vigorous physical activity and risk of type 2 diabetes in women. *JAMA* 282: 1433-1439, 1999.

27. Johansson, S. E. and J. Sundquist. Change in lifestyle factors and their influence on health status and all-cause mortality. *Int J Epidemiol.* 28: 1073-1080, 1999.
28. Kriska, A. M., R. B. Sandler, J. A. Cauley, R. E. LaPorte, D. L. Hom, and G. Pambianco. The assessment of historical physical activity and its relation to adult bone parameters. *Am J Epidemiol.* 127: 1053-1063, 1988.
29. Laukkanen, R. M., T. K. Kukkonen-Harjula, P. Oja, M. E. Pasanen, and I. M. Vuori. Prediction of change in maximal aerobic power by the 2-km walk test after walking training in middle-aged adults. *Int J Sports Med* 21: 113-116, 2000.
30. Lee, I-Min., Rexrode, K. M, Cook, N. R, Manson, J. E., and Buring, J. E. Physical Activity and Coronary Heart Disease in Women. Is "No Pain, No Gain" Passé? *JAMA* 285, 1447-1454. 2001.
31. Lee, I. M. and R. S. Paffenbarger, Jr. Associations of light, moderate, and vigorous intensity physical activity with longevity. The Harvard Alumni Health Study. *Am J Epidemiol.* 151: 293-299, 2000.
32. Manson, J. E., D. M. Nathan, A. S. Krolewski, and M. J. Stampfer. A Prospective Study of Exercise and Incidence of Diabetes Among US Male Physicians. *JAMA* 268: 63-67, 1992.

33. Mayers-Davis, E. J., R. D'Agostino, A. J. Karter, S. M. Haffner, M. J. Rewers, M. Saad, and R. N. Bergman. Intensity and Amount of Physical Activity in Relation to Insulin Sensitivity. The Insulin Resistance Atherosclerosis study. *JAMA* 279: 669-673, 1998.
34. McArdle, W., F. Katch, and V. Katch. Energy expenditure of walking on a level surface at different speeds. Exercise Physiology, energy, nutrition, and human performance. Williams and Wilkins. Baltimore. 169. 1996.
35. McMurray, R. G., B. E. Ainsworth, J. S. Harrell, T. R. Griggs, and O. D. Williams. Is physical activity or aerobic power more influential on reducing cardiovascular disease risk factors? *Med Sci Sports Exerc.* 30: 1521-1529, 1998.
36. Miller, G. J., G. H. Maude, and G. L. Beckles. Incidence of hypertension and non-insulin dependent diabetes mellitus and associated risk factors in a rapidly developing Caribbean community: the St James survey, Trinidad. *J Epidemiol. Com Health* 50: 497-504, 1996.
37. Oja, P., R. Laukkanen, M. Pasanen, T. Tyry, and I. Vuori. A 2-km walking test for assessing the cardiorespiratory fitness of healthy adults. *Int J Sports Med* 12: 356-362, 1991.
38. Paffenbarger, R. S., A. L. Wing, and R. T. Hyde. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 108: 161-175, 1978.

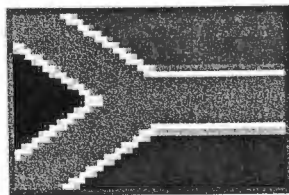
39. Paffenbarger, R. S., Jr., J. B. Kampert, I. M. Lee, R. T. Hyde, R. W. Leung, and A. L. Wing. Changes in physical activity and other lifeway patterns influencing longevity. *Med Sci Sports Exerc.* 26: 857-865, 1994.
40. Paffenbarger, R. S., Jr., A. L. Wing, and R. T. Hyde. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 108: 161-175, 1978.
41. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A recommendation From the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273: 402-407, 1995.
42. Pereira, M. A., A. M. Kriska, M. L. Joswiak, G. K. Dowse, V. R. Collins, P. Z. Zimmet, H. Gareeboo, P. Chitson, F. Hemraj, and A. Purran. Physical inactivity and glucose intolerance in the multiethnic island of Mauritius. *Med Sci Sports Exerc.* 27: 1626-1634, 1995.
43. Ransdell, L. B. and C. L. Wells. Physical activity in urban white, African-American, and Mexican- American women. *Med Sci Sports Exerc.* 30: 1608-1615, 1998.
44. Sallis, J. F., W. L. Haskell, P. D. Wood, S. P. Fortmann, T. Rogers, S. N. Blair, and R. S. Paffenbarger, Jr. Physical activity assessment methodology in the five-city project. *Am J Epidemiol.* 121: 91-106, 1985.

45. Sidney, S., D. R. Jacobs, Jr., W. L. Haskell, M. A. Armstrong, A. Dimicco, A. Oberman, P. J. Savage, M. L. Slattery, B. Sternfeld, and L. Van Horn. Comparison of two methods of assessing physical activity in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Epidemiol.* 133: 1231-1245, 1991.
46. Steyn, K., J. Fourie, and D. Bradshaw. The impact of chronic diseases of lifestyle and their major risk factors on mortality in South Africa. *S Afr Med J* 82: 227-231, 1992.
47. Steyn, K., J. E. Rossouw, P. L. Jooste, D. O. Chalton, E. R. Jordaen, P. C. Jordaen, M. Steyn, and A. S. Swanepoel. The intervention effects of a community-based hypertension control programme in two rural South African towns: the CORIS Study. *S Afr Med J* 83: 885-891, 1993.
48. Strath, S. J., A. M. Swartz, D. R. Bassett, W. L. O' Brian, G. A. King, and B. E. Ainsworth. Evaluation of heart rate as a method for assessing moderate intensity physical activity. *Med Sci Sport Exerc.* 32: S456-S470, 2000.
49. Taylor, R., J. Badcock, H. King, K. Pargeter, P. Zimmet, T. Fred, M. Lund, H. Ringrose, F. Bach, and R. L. Wang. Dietary intake, exercise, obesity and noncommunicable disease in rural and urban populations of three Pacific Island countries. *J Am Coll.Nutr.* 11: 283-293, 1992.

50. Wyndham, C. H., N. B. Stydom, C. H. van Graan, A. J. van Rensburg, G. G. Rogers, and J. S. Greyson. Walk or Jog for health: I. The energy costs of walking or running at different speeds. *S Afr Med J* 50: 1971.

CHAPTER FOUR.

VALIDITY AND RELIABILITY OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ) IN AN URBAN SOUTH AFRICAN POPULATION USING THE COMPUTER SCIENCE AND APPLICATIONS, INC (CSA) ACTIVITY MONITOR.



ABSTRACT

Physical activity assessment has become increasingly important in establishing the relationship between inactivity and disease. However, there is lack of agreement and uniformity in the assessment of physical activity for public health purposes. Physical activity questionnaires demonstrate a widely varying reliability and validity, depending on the context in which they are tested. There are few examples of validated physical activity questionnaires used in a cross-cultural context. The International Physical Activity Questionnaire (IPAQ) was recently developed by a World Health Organisation/Centres for Disease Control working group in response to this need. **Purpose:** The aim of this study was to assess the validity and reliability of the IPAQ in an urban South African population. **Methods:** A long and short version of the IPAQ (version 8) was interviewer-administered to 34 male and 47 female urban living subjects, who represented divergent language, educational, socio-economic and occupational groups. The long IPAQ measures the average weekly time and energy expenditure spent in one's occupation, transport-related activities, household chores, and leisure time activities. The short IPAQ measures the total time and energy expended in moderate, vigorous, walking and sitting-related activity. Test-retest reliability was reported as the intra-class correlations between calculated time and energy expenditure ($\text{METmin}\cdot\text{wk}^{-1}$) in different questionnaire items determined from three IPAQ administrations. Criterion validity was determined by the simultaneous measurement of body motion using a uniaxial accelerometer (CSA, Inc, model 7162) to quantitate physical activity. Other validity criteria included BMI, estimated VO_2max and % fat. **Results:** Test-retest reliability for the long IPAQ ranged from $r = 0.38$ to $r = 0.75$, with the highest intra-class correlation coefficients obtained in work related activities, and the lowest in household

chores. Test-retest reliability in short IPAQ ranged from $r = 0.32$ to $r = 0.71$, with the highest intra-class correlations obtained in sitting and the lowest in total moderate activity. Criterion validity for CSA counts and total physical activity in the long IPAQ was $r = 0.48$ ($P < 0.001$), for WORK was $r = 0.51$ ($P < 0.001$) and for LTPA $r = 0.35$ ($P < 0.01$). Measurement of reliability and validity in this South African population compared favorably to physical activity questionnaires used in other population studies. **Conclusion:** The IPAQ provides a relatively valid and reliable estimate of physical activity across age, gender, education and socio-economic status.

Key words: ENERGY EXPENDITURE, REPEATABILITY, ACCELEOMETER.

INTRODUCTION

In the previous study (6), the terminology used to describe physical activity intensity in a prototype physical activity questionnaire was tested for validity. We determined whether the terminology 'moderate' and 'vigorous' were understood and uniform across gender, age, occupation, education, language and culture. However, it is not known to what extent these factors could also potentially affect physical activity recall (6).

The measurement of physical activity prevalence has become important in public health surveillance, clinical medicine and epidemiology, especially because of the now well-described relationship between physical activity levels and health. More specifically, physical activity has shown an inverse association with a variety of chronic diseases, such as coronary heart disease (1;31;46;47), hypertension (9;21;27;34), non-insulin dependant diabetes mellitus (24;33;36;39), obesity (3;10;13;48), osteoporosis (17;30) and hypercholesterolaemia (2;4;14). These associations are robust and likely to be causal (32). Furthermore, there is a dose-response relationship between physical activity and mortality rate: the higher the level of physical activity, the lower the mortality rate (38).

However, in some cases there is a failure of, or weak, association between physical activity and chronic disease (14;22;45). This finding may be the result of the measurement of physical activity. For example, the instrument used, the manner in which the raw data was scored and the characteristics of the questionnaire (including specificity and sensitivity) may affect estimates of physical activity. This lack of association between physical activity and chronic disease could also be due to a lack of a "protective" effect of physical activity for a

specific condition, or in that specific population. Alternatively, the “protective” effect may be the result of lifetime physical activity and not of current physical activity levels.

It has been difficult to compare studies across countries, and across cultures within countries, due to the lack of an internationally validated questionnaire. Also, few countries actually include physical activity monitoring in national health risk surveys. In recognition of this problem, the World Health Organization (WHO), in conjunction with the US Centers for Disease Control (CDC), conducted a workshop on the ‘*Standardization of the assessment of physical activity for public health purposes*’ in Geneva, Switzerland in 1998. Representatives from 14 countries (in Asia, Australia, North and South America, Africa and Europe) contributed towards the formulation of an ‘International Physical Activity Questionnaire’ (IPAQ). This questionnaire was developed as a response to a lack of a culturally-sensitive questionnaire, validated against a physiological standard and which accurately reflected graded levels of habitual physical activity (4;23). The proposed IPAQ was designed to measure physical activity for public health purposes in a wide variety of settings and be suitable in a cross cultural context. The objective was for the IPAQ to be a) short enough for inclusion in national demographic and health risk surveys and b) simple enough to administer to persons with low levels of literacy.

Physical activity questionnaires do however have their limitations. A major problem is that no “gold standard” exists for the validation of various questionnaires that can be used in large sample population studies (4;23). There is, however, a need to standardize measures of physical activity used in population studies, particularly since it has been shown that self-

reported physical activity can be inherently biased (43). It is also important to assess a questionnaire's validity and reliability for every population in which it will be used (41).

Therefore, the aim of this study was to use an international testing protocol to establish the test-retest reliability of the IPAQ in an urban South African population, and to test validity by the simultaneous measurement of body motion counts in a single vertical plane to quantitate physical activity.

METHODS

Subjects. Subjects were selected from a convenience sample of urban South African men (N = 34) and women (N = 47). The sample included members of churches, a corporate cleaning company, two community recreation centers, university administration, a large consumer goods corporation and a small investment company. The subjects were between the ages of 18 and 39 years and had a wide range of income, education and physical activity levels, as stipulated by the international protocol established to validate the IPAQ. The study was approved by the Ethics and Research Committee of the Faculty of Health Sciences, University of Cape Town and informed, written consent was obtained from all subjects.

Eligibility requirements for study participation included a) absence of acute illness b) use of medication for chronic disease and c) age 18- 39 years. Every effort was made to select subjects who represented a broad spectrum of socioeconomic and educational backgrounds.

Experimental protocols. Body mass and height was measured using a Health-O-Meter balance beam scale (Bridgeview, Illinois, USA). Body mass was measured to the nearest 0.5 kg with the subjects wearing light clothing and without shoes. Height was measured without shoes to the nearest centimeter. Body mass index (BMI) was calculated by dividing body mass (kg) by height squared (m^2) ($BMI = kg \cdot m^{-2}$). Skinfold thicknesses were measured using a Bodycare™ Harpenden caliper (England) at four sites: bicep, triceps, suprailliac and subscapula, and body fat % was estimated using the equation of Durnin and Womersley (16). Maximal oxygen consumption (VO_{2max}) was predicted from a validated step test (20).

The accelerometer. Computer Science and Applications, Inc (CSA) activity monitors (Model 7162, Shalimar, FL, USA) were used to measure the body's accelerations in a uniaxial plane. The CSA was attached to the subject's belt around the waist, and worn on the right anterior hip for seven consecutive days. It was important that the belt fitted snugly so that the device could not bounce around. The CSA was worn continuously throughout the day and was only removed when the subject's went to bed at night. When the subject was in contact with water, such as bathing, showering or swimming, the monitor was removed and attached immediately thereafter. If the subject forgot to wear the CSA, they were instructed to continue to wear it as soon as they remembered. However a note was made of this and their CSA data could only be used if at least five full days of data was collected. CSA data from fourteen subjects were lost due to inconsistent wearing of the monitor on behalf of the subject.

Subjects were told that a typical week of their physical activity was required and were asked not to alter their usual patterns of activity because they were wearing the monitor. The monitors were collected seven days later and the data were immediately transferred so that the monitors could be reinitialized for the next group of subjects. A 60-second epoch was used for data capture and all initializing was done according to manufacturer specifications. A minimum of 10 hours per day of data were needed for analysis. The same count cut-off values used to equate motion counts per minute to exercise intensity published by Freedson et al. (1998) were used for the analysis (e.g. a moderate activity was equivalent to $1952\text{--}5724\text{ counts}\cdot\text{min}^{-1}$) (19). These count cut-off values allowed the calculation of the minutes per day spent in moderate, vigorous and very vigorous activity. Continuous periods of activity, total registered time, total counts and counts per registered time were also analyzed.

The Step Test. The Kasch Three-Minute Step Test (20) was used as an estimate of cardiovascular fitness. The test was chosen on the basis that it was practical to administer in the field, and required minimal familiarization. Subjects were instructed to warm up by stretching their calf, hamstring and quadriceps muscles before starting the test. The test consisted of stepping on a 30 cm bench for three minutes at a rate of 24 steps per minute (or 96 beats per minute). Five seconds after the stepping protocol ended, the subject's heart rate was measured manually, at the radial artery, for 60 seconds. A gender and age-specific rating of cardiovascular fitness was then allocated according to heart rate response (20).

The Questionnaire. The following items were standardized by the international IPAQ executive to ensure good test-retest reliability: a) questionnaire administration, b) data

cleaning and c) data analysis. The International Physical Activity Questionnaire (IPAQ) (WHO-CDC International working group, 1998) (7) was used to estimate habitual levels of moderate and vigorous physical activity based on frequency, intensity and duration. The questionnaire was modified slightly for South Africans by providing culturally specific examples of activities (South African working group, unpublished communication, 1998). There was a long and a short version of the IPAQ comprising of 31 and 9 questions respectively. Both versions queried activity that occurred in a 'usual week' and both were interviewer administered (as opposed to telephone or self- administered).

The long version of the IPAQ assessed physical activity in four domains: (i) occupational physical activity (WORK), (ii) transportation physical activity (TRANS), (iii) household chores- garden/yard work (HOME) and, (iv) leisure-time, sport and recreational physical activity (LTPA). Subjects were instructed to make clear distinctions between each domain to avoid possible overlap. The mean total weekly energy expenditure (grand total physical activity- GTPA) was calculated, as well as each domain's subtotals, in $\text{MET} \cdot \text{min} \cdot \text{wk}^{-1}$. One MET represents the approximate rate of oxygen consumption of a seated adult at rest, or about $3.5 \text{ mL} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$. This equates to an energy cost of about $4.2 \text{ kJ} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ ($1 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$). The total amount of time spent sitting (SIT) for example at home, at work, during transportation, watching television or studying was also calculated from the IPAQ.

The short version of the IPAQ measured the total time and energy expended in moderate, vigorous, walking and sitting-related activity ($\text{MET} \cdot \text{min} \cdot \text{wk}^{-1}$) without differentiating between specific domains. Both questionnaires were administered on three different

occasions; on day one, day eight and day eleven. The long and the short versions of the IPAQ were administered in a random order between subjects. The order for all three administrations was kept the same for each subject.

The IPAQ was also translated into Afrikaans and Xhosa (ethnic South African languages) according to the international protocol. This process included careful translating and back-translating by people with and without a physical activity background. The questionnaire was administered to the subject in the language of their choice, and a trained interviewer, who was fluent in that language, administered the IPAQ. Although the IPAQ could be administered in different languages by the interviewer, the subject's answers were always written on an English questionnaire, which facilitated data capture and analysis later on.

Visit One (day 1): Subjects were introduced to all testers, briefed on the purpose of the study and explained the testing procedure (including the importance of attending all tests and returning the CSA monitors). The subject filled in an informed consent and subject tracking form, as well as a demographic and medical history questionnaire. The subjects were given instructions for the appropriate wearing and care of the CSA monitor and both the long and short versions of the IPAQ were administered by an interviewer. Height and weight were also measured.

Visit Two (day 8): Both IPAQs and the step test were administered. Sum of skinfold thicknesses were measured and the CSA monitors were collected from the subjects and the data transferred.

Visit Three (day 11): The subjects were given their cardiovascular fitness and body fat % results. Both versions of the IPAQ were administered and subjects were thanked for their time.

Statistical Analysis: STATISTICA software (Statsoft, Inc. 1984-1999, Tulsa, OK) for Windows 98 was used for all analyses. Tabular data are presented as mean \pm standard error of the mean (SEM). All data were checked by conducting double data entry and random sampling of data entries. Although over-reporting of physical activity was a possibility, there was no exclusion of outliers.

The physical activity scores were weighted by assigning 3 METS to all moderate activities. All vigorous activities were assigned 6 METs, except for vigorous yard/garden activities which were assigned 5 METs. All cycling was assigned 5 METs, and all walking 3 METs, regardless of the reported pace (i.e slow, moderate or vigorous). All sitting was assigned 1 MET. The physical activity scores ($\text{METmin}\cdot\text{wk}^{-1}$) were calculated by multiplying the frequency (days per week) by the duration (minutes) and the appropriate MET for that activity.

Independent t-tests were used to detect differences between men and women for subject characteristics. The Mann-Whitney U test was used to detect differences between men and women for the administration of the long IPAQ on visit one. A Wilcoxon matched pairs test was used to detect differences between the long and the short IPAQ on visit one. Total physical activity for the long and the short IPAQ (for visit one) was further divided into

quartiles. These quartiles were analyzed with a chi-squared test to determine whether individuals would be classified similarly in terms of higher or lower physical activity energy expenditure quartiles, if the questionnaires were used interchangeably.

The data were not normally distributed, therefore nonparametric statistics were used. Spearman's rank order correlation coefficients (r) was used to determine concurrent validity (long vs. short) and criterion validity (IPAQ vs. CSA). Intraclass correlation coefficients (ICC) were used to determine reliability.

Repeated measures analysis of variance (ANOVA) and the intraclass correlation coefficients were used to determine the reliability or consistency of the measurements of selected variables between visits all three visits. The intraclass correlation coefficient was calculated by: $MS_R - MS_{C+E} / MS_R$, where MS_R is the mean square of the subjects' reported physical activity and MS_{C+E} is the sum of changes in the mean of the three trials and the error (49). An intraclass correlation coefficient greater than $r = 0.90$ is considered high, from $r = 0.80$ to $r = 0.89$ moderate to high, from $r = 0.70$ to $r = 0.79$ acceptable and below $r = 0.70$ questionable (49).

Limits of agreement between visit one and two of the IPAQ was graphically presented using the Altman and Bland technique (5;7). In accordance with this procedure, the difference between each pair of values is plotted against their mean, and the graph is inspected to see if the measure has accepted reliability by having at least 95% of the differences located within two standard deviations of the mean of the differences (5). In most instances the first

administration of the IPAQ is the one of interest, since the questionnaire will not normally be administered three times for epidemiological studies or cross-sectional risk surveys.

When analyzing the CSA Inc. data, the average time the monitor was worn by the subject was considered the “registered time”. That is the number of minutes from the first registration of the first day to the last day. All minutes without registration, i.e. “zero counts”, were deleted if there were more than ten “zero counts” in a row. It was assumed that the monitor was not worn for this period of time. For analysis, the “counts per registered time” was used, implying that the raw data had been cleaned to include only those periods which the monitor was worn.

RESULTS

Descriptive statistics

Mean levels of descriptive data (\pm standard error of the mean) are shown in **Table 4.1a**. Subject characteristics are presented as frequencies in **Table 4.1b**. These results demonstrate recruitment efforts were successful in achieving a sample population that was relatively well balanced by age, gender and education. The men in this study were significantly taller than the women ($P < 0.00001$), had higher predicted $VO_{2\max}$ values ($P < 0.00001$) and lower body fat % ($P < 0.00001$) than the women. There were no significant differences between men and women in age, BMI, body weight, housing density or education. Men worked significantly more hours per week in their place of employment than women ($P < 0.05$). Women had significantly larger households (more people per house) than men ($P < 0.05$).

Table 4.1a. Subject characteristics (\pm SEM).

Variable	Male (N = 34)	Female (N = 47)	P- value
Age (yr)	30 \pm 1	30 \pm 1	0.56
Height (cm)	175 \pm 1	161 \pm 1	0.00**
Mass (kg)	79 \pm 3	71 \pm 2	0.04
BMI[#] (kg·m²)	25.7 \pm 0.8	27.8 \pm 1.0	0.12
Predicted VO_{2max} (mlO₂·kg⁻¹·min⁻¹)	41.8 \pm 1.8	31.5 \pm 1.3	0.00**
Body fat (%)	19 \pm 1	32 \pm 1	0.00**
Time spent at work (h·wk⁻¹)	43 \pm 3	37 \pm 2	0.04*
Housing density (people per room)	1.7 \pm	2.1 \pm	0.23
Housing (people per house)	4 \pm 0	5 \pm 0	0.04*
Education (years)	13.5 \pm 0.5	12.9 \pm 0.4	0.34
[#] BMI = body mass index. * P < 0.05 ** P < 0.00001			

Table 4.1b. Descriptive statistics (distribution) of the study population (N=81).

	N	Frequency
Age 18-30 years	40	49%
Age 31-39 years	41	51%
Male	34	42%
Female	47	58%
Education- completed ≤ 12 years	38	47%
Education- completed >12 years	43	53%
Formally employed	77	95%
Housing density		
(≤ 2 people per room)	67	83%
(> 2 people per room)	14	17%

Table 4.2 shows the habitual energy expenditure in both men and women for all domains of physical activity as reported on visit one, using the long IPAQ. Men reported significantly more leisure time physical activity than women (2248 ± 395 vs. 1214 ± 236 METmin·wk⁻¹, $P < 0.05$). There were, however, no significant differences in habitual energy expenditure between men and women on the second and third administration of the long IPAQ. Furthermore, there were also no differences reported between men and women for the short IPAQ on the first, second or third administration (not shown).

Men on average worked more hours per week than women (43 ± 3 vs. 37 ± 2 h·wk⁻¹, $P < 0.05$). When physical activity in the home was divided and reanalyzed with physical activity inside the home vs. physical activity in the garden/yard, men were significantly more physically active in the garden/yard (558 ± 208 vs. 174 ± 59 METmin·wk⁻¹, $P < 0.05$) than women.

Table 4.2. Independent t- test to detect differences between men and women for the long IPAQ on visit one.

IPAQ Items (METmin·wk⁻¹)	MEN (±SEM)	WOMEN (±SEM)	P
WORK	3928 ± 732	3390 ± 664	0.59
TRANS	608 ± 278	575 ± 165	0.91
HOME	1006 ± 275	1117 ± 224	0.75
LTPA	2248 ± 395	1214 ± 236	0.02*
GTPA	7790 ± 1241	6296 ± 955	0.33
SIT	3219 ± 223	3042 ± 171	0.52

(* P < 0.05)

MET= Work metabolic rate/ resting metabolic rate. One MET represents the approximate rate of oxygen consumption of a seated adult at rest, or about 3.5mL·min⁻¹·kg⁻¹. This equates to an energy cost of about 4.2 kJ·kg⁻¹·hr⁻¹ (1 kcal·kg⁻¹·hr⁻¹). All IPAQ items measured time and energy (METmin·wk⁻¹) in a "usual" week and could only be recorded if the activity was carried out for more than 10 minutes at a time. WORK: walking or performing moderate and vigorous activities at work. TRANS: walking or cycling to go from place to place (e.g. to work, movies or shopping). HOME: moderate or moderately vigorous chores *in* and *around* the home (e.g. Housework, gardening, maintenance, caring for family). LTPA: time and energy spent in physical activity for recreation, sport, exercise or leisure. GTPA: grand total of time and energy spent in physical activity performed at WORK, HOME, TRANS and LTPA. SIT: time spent sitting while at work, at home or during leisure time (including time spent sitting travelling in a motor vehicle).

Test-retest Reliability. Table 4.3a presents the intra-class correlation coefficients (ICC) for reproducibility for the long IPAQ for all three visits. Reliability between visits one and two ranged from $r = 0.38$ (HOME) to 0.75 (WORK). Reliability between visits two and three was much higher and ranged from $r = 0.76$ (LEISURE-TIME PHYSICAL ACTIVITY) to 0.91 (GRAND TOTAL PHYSICAL ACTIVITY). For visits one-two, reliability was lower for household chores and transport-related activity than for sitting-, occupational- and leisure time-related activities. Total physical activity showed good reliability ($r = 0.74$).

Table 4.3b shows the reliability between visits one and two in the short IPAQ which ranged from $r = 0.32$ (TOTAL MODERATE) to 0.72 (TOTAL PHYSICAL ACTIVITY). Reliability between visits two and three was higher and ranged from $r = 0.46$ (TOTAL VIGOROUS) to 0.92 (SITTING). For visits one-two, total moderate physical activity and total walking showed the lowest reliability and total vigorous physical activity and sitting showed the highest reliability. Total physical activity showed good reliability ($r = 0.72$). Reliability was higher for visits two-three, than visits one-two, for both the long and the short IPAQ. Total physical activity showed acceptable reliability in both questionnaires (both above 0.70).

The data for test-retest reliability are presented in Tables 4.3c and 4.3d, for the long and short IPAQ, for the overall sample, and for the respective demographic groups (education, age, gender and housing density). In the long IPAQ (Table 4.3c), there were important differences in the reliability of TRANSPORT, LEISURE-TIME PHYSICAL ACTIVITY and SITTING. Lower education (< 12 years) decreased the reliability of TRANSPORT,

LEISURE-TIME PHYSICAL ACTIVITY and SITTING. Males were less reliable than females in reporting TRANSPORT and LEISURE-TIME PHYSICAL ACTIVITY , however not SITTING ($r = 0.371$ females vs. $r = 0.796$ males). Subjects aged 31-39 years reported TRANSPORT more reliably than subjects 18- 30 years ($r = 0.793$ vs. $r = 0.554$ respectively). However, younger subjects (18- 30 years) reported LEISURE-TIME PHYSICAL ACTIVITY and SITTING more reliably.

Higher education (> 12 years) improved the test-retest reliability of WORK, TRANSPORT, LEISURE-TIME PHYSICAL ACTIVITY, GRAND TOTAL PHYSICAL ACTIVITY and SITTING. Younger subjects (18- 39 years) reported HOME, LEISURE-TIME PHYSICAL ACTIVITY , GRAND TOTAL PHYSICAL ACTIVITY and SITTING more reliably. Males were more reliable in reporting WORK, HOME, GRAND TOTAL PHYSICAL ACTIVITY and SITTING than females. Those with a lower housing density (< 1.5 people per room) were more reliable in reporting TRANSPORT, HOME, and SITTING, compared with those with a higher housing density (> 1.5 people per room).

In the short IPAQ there were also important differences. Walking especially showed weak reliability ($r = 0.35$), however, higher age, less education, females and higher housing density all improved the reliability of walking. Reliability of walking was also higher in women, Of particular note is the improvement that higher education made to the test-retest reliability of all the variables. For example, higher education (> 12 years) for VIGOROUS activity was $r = 0.71$, $P < 0.00001$ and for lower education (< 12 years) was $r = 0.16$ (NS).

For TOTAL activity, a higher education had a correlation of $r = 0.73$, $P < 0.000001$ and lower education had a correlation of $r = 0.429$, $P < 0.05$.

Mean values (\pm SEM) of the long and the short IPAQ on visit one are reported in **table 4.4a**. Total moderate activity, total sitting and total physical activity differed significantly between the long and the short IPAQ, with the long IPAQ energy expenditure ($\text{METmin}\cdot\text{wk}^{-1}$) being greater than the short ($P < 0.001$ for all three respectively). The mean Total moderate activity between the long and the short IPAQ differed by almost $1000 \text{ METmin}\cdot\text{wk}^{-1}$, Total physical activity differed by nearly $2300 \text{ METmin}\cdot\text{wk}^{-1}$, and Total sitting by nearly $500 \text{ METmin}\cdot\text{wk}^{-1}$. Interestingly, 12% of the subjects reported no LEISURE TIME PHYSICAL ACTIVITY ($0 \text{ METmin}\cdot\text{wk}^{-1}$) on visits one and two, and 7% reported no LEISURE TIME PHYSICAL ACTIVITY on visit three. Seventeen percent of subjects reported no HOME activity on visit one, 15% on visit two and 11% on visit three. For WORK, 20% reported no activity on visit one, 23% on visit two and 19% on visit three. For TRANS, 33% reported no activity on visit one, 27% on visit two and 22% on visit three.

Absolute values for total physical activity for the long and the short IPAQ were divided into quartiles (**Table 4.4b**) to classify subjects into levels of habitual physical activity. Chi-squared analysis was further done in order to determine whether subjects were classified into the same activity quartile for both the long and the short IPAQ (**Table 4.4c**). Sixty percent of subjects who were classified in the lowest quartile for the long IPAQ, were also classified in the lowest quartile for the short IPAQ. For quartile two, three and four, 60%, 52% and 71% were classified in the same category respectively.

Figure 4.1 and 4.2 show the energy expenditure (\pm SEM) for the long and the short IPAQ in visit one, two and three. The long IPAQ is divided into total moderate, vigorous, walking and sitting, regardless of whether it was performed at work, at home, during transport or leisure time.

Validity. Concurrent validity, obtained by comparing the long IPAQ to the short IPAQ, is shown in **Table 4.5**. The purpose of obtaining concurrent validity was to assess whether these two tools were comparable, and whether, for example, moderate activity measured in the short IPAQ reflected moderate activity measured with the long IPAQ. The results reported as Spearman r , show that Total physical activity vs. GRAND TOTAL PHYSICAL ACTIVITY had the highest concurrent validity ($r = 0.79$) and walking had the lowest ($r = 0.43$) on the first visit. As expected, all IPAQ items improved their concurrent validity from the first to the second and the third visit, except for moderate and walking activity (which decreased slightly on visit three). The concurrent validity of TOTAL activity ($r = 0.79$) was also particularly high on visit one.

Table 4.6 provides an overview of the correlation between the long IPAQ at visit one and BMI ($\text{kg}\cdot\text{m}^{-2}$), predicted VO_2 max ($\text{ml}\cdot\text{kg}\cdot\text{min}^{-1}$) and % body fat (validation criteria), as well as age, perceived health and education. Cardiorespiratory fitness (predicted VO_2max) was positively related to LEISURE TIME PHYSICAL ACTIVITY ($r = 0.365$, $P < 0.01$) and total vigorous physical activity ($r = 0.328$, $P < 0.01$), and inversely related to TRANSPORT ($r = -0.274$, $P < 0.05$) and SITTING ($r = -0.226$, $P < 0.01$). Body fatness and LEISURE

TIME PHYSICAL ACTIVITY were inversely related ($r = -0.415$, $P < 0.001$) as well as body fatness and total vigorous physical activity ($r = -0.368$, $P < 0.001$). Body fatness and cardiorespiratory fitness can explain approximately 42% and 37% of the variance found in LEISURE TIME PHYSICAL ACTIVITY respectively. Contrary to the author's expectations, BMI was positively associated with HOME ($r = 0.224$, $P < 0.05$) and inversely associated with SITTING ($r = -0.237$, $P < 0.05$). However, as expected, increasing age was inversely associated to LEISURE TIME PHYSICAL ACTIVITY ($r = -0.321$, $P < 0.001$) and total vigorous physical activity ($r = -0.222$, $P < 0.05$). Subjects who perceived themselves as having good health, participated in increasing LEISURE TIME PHYSICAL ACTIVITY ($r = -0.263$, $P < 0.05$) and decreasing HOME activity ($r = 0.267$, $P < 0.05$). Increasing education was significantly associated with less WORK, TRANSPORT, HOME, GRAND TOTAL PHYSICAL ACTIVITY and total moderate physical activity. However, increasing education was also associated with increased LEISURE TIME PHYSICAL ACTIVITY and SITTING.

Criterion validity. The criterion validity reported from CSA counts vs. the long IPAQ are found in **Table 4.7**. The highest criterion validity was reported with total work energy expenditure vs. total CSA counts ($r = 0.508$) as well as total moderate activity vs. total moderate CSA METmin ($r = 0.487$). The lowest criterion validity was found in Total Home vs. counts/reg⁻¹time ($r = 0.016$, NS). In **Table 4.8**, the criterion validity between the short IPAQ and CSA counts was reported. Altogether, the criterion validity was lower for the short IPAQ than the long IPAQ. The highest validity coming from total physical activity vs.

CSA counts per registered time ($r = 0.333$) and the lowest validity coming from vigorous METmins·wk⁻¹ vs. high CSA counts ($r = 0.186$).

Limits of agreement. Figures 4.3 to 4.8 reports the limits of agreement for total, moderate and vigorous energy expenditure for the long and short IPAQ (reliability). The data show consistent results. There was a tendency to report a higher energy expenditure on visit 2, especially at higher levels of energy expenditure. However, the agreement in terms of METmin·wk⁻¹ between visits one and two was not very encouraging (delta values of -14914 to 16287 METmin·wk⁻¹ for the long and -11100 to 11107 METmin·wk⁻¹ for the short IPAQ). In most of the examples provided, the limits of agreement were worse and diverge at higher levels of energy expenditure. These trends in lack of agreement are common to the long and short questionnaire.

Table 4.3a: Intraclass correlation coefficients (ICC) for reliability assessment of the three administrations (day 1, 8 and 11) of the International Physical Activity Questionnaire (IPAQ) long format (N = 81).

Long IPAQ items (METmin·wk⁻¹)	Visit one-two r	Visit two-three r
WORK	0.752	0.882
TRANS	0.561	0.808
HOME	0.384	0.840
LTPA	0.730	0.761
GTPA	0.741	0.913
SIT	0.696	0.809

IPAQ items are explained in the legend of Table 4.2.

Table 4.3b: Intraclass correlation coefficients (ICC) for reliability assessment of the three administrations (day 1, 8 and 11) of the International Physical Activity Questionnaire (IPAQ) short format (N = 81).

Short IPAQ items (METmin·wk ⁻¹)	Visit one-two r	Visit two-three r
TOTAL MODERATE	0.315	0.600
TOTAL VIGOROUS	0.674	0.464
TOTAL WALKING	0.466	0.706
TOTAL PHYSICAL ACTIVITY	0.715	0.770
SITTING	0.685	0.917

All IPAQ items measured time and energy (METmin·wk⁻¹) in a “usual” week and could only be recorded if the activity was carried out for more than 10 minutes at a time. **TOTAL MODERATE**: moderate activities at work, at home, for transport or during leisure time. **TOTAL VIGOROUS**: vigorous activities at work, at home, for transport or during leisure time. **TOTAL WALKING**: walking at work, for transport or for leisure/exercise. **TOTAL PHYSICAL ACTIVITY**: total of moderate, vigorous and walking activities. **SITTING**: sitting, at work, at home, during transportation and leisure time.

Table 4.3c. Test-retest reliability for long IPAQ between visit one and two- overall and for various demographic variables.

IPAQ item	Spearman rank order correlation (r)								
	Overall N = 81	Education		Age		Gender		Housing density	
		≤ 12 years N=38	>12 years N=43	18-30 years N=40	31-39 years N=41	Male N=34	Female N= 47	<1.5 ppr N=37	≥1.5 ppr N=44
WORK	0.845 **	0.777 **	0.800 **	0.851 **	0.855 **	0.879 **	0.824 **	0.819 **	0.838 **
TRANS	0.698 **	0.545 *	0.776 **	0.554 *	0.793 **	0.674 *	0.753 **	0.723 *	0.674 **
HOME	0.648 **	0.661 **	0.556 *	0.695 **	0.543 *	0.698 **	0.598 **	0.658 *	0.634 **
LTPA	0.680 **	0.508 *	0.784 **	0.698 **	0.568 *	0.647 **	0.653 **	0.639 *	0.701 **
GTPA	0.735 **	0.673 **	0.738 **	0.798 **	0.678 **	0.791 **	0.693 **	0.688 *	0.742 **
SIT	0.584 **	0.307 *	0.773 **	0.643 **	0.558 *	0.796 **	0.371 #	0.580 *	0.555 *

P < 0.05, * P < 0.0001, ** P < 0.000001. Legend for IPAQ items appears in Table 4.2.

Shading denotes differences between two subcategories.

ppr = persons per room

Table 4.3d. Test-retest reliability of the short IPAQ between visit one and two- overall and for various demographic variables.

IPAQ item	Spearman rank order correlation (r)								
	Overall N = 81	Education		Age		Gender		Housing density	
		≤ 12 years N=38	>12 years N=43	18-30 years N=40	31-39 years N=41	Male N=34	Female N= 47	<1.5 ppr N=37	≥1.5 ppr N=44
VIGOROUS	0.408 ****	0.162	0.709 *****	0.504 **	0.333 *	0.301	0.457 **	0.568 **	0.298 *
MODERATE	0.482 ****	0.387 *	0.576 ***	0.434 **	0.530 **	0.574 **	0.412 **	0.506 **	0.456 **
WALKING	0.351 ***	0.425 *	0.354 *	0.242	0.416 **	0.250	0.432 **	0.550 **	0.191
TOTAL	0.600 ****	0.429 *	0.726 *****	0.608 ***	0.587 ***	0.554 **	0.599 *****	0.578 **	0.566 ***
SITTING	0.602 ****	0.517 *	0.549 **	0.624 ***	0.558 **	0.650 *****	0.521 **	0.512 **	0.665 *****

P < 0.05, ** P < 0.01, *** P < 0.0001, **** P < 0.000001. Legend for IPAQ items appears in Table 4.2. Shading denotes differences between subcategories
ppr = persons per room

Table 4.4a. Concurrent validity. Mean values (\pm SEM) of the long and short format of the IPAQ on visit one (N = 81).

IPAQ item (METmin·wk ⁻¹)	Long METmin·wk ⁻¹	Short METmin·wk ⁻¹	P-value
TOTAL MODERATE ACTIVITY	2323 \pm 180	1324 \pm 130	0.000*
TOTAL VIGOROUS ACTIVITY	2172 \pm 228	1760 \pm 170	0.166
TOTAL WALKING	2945 \pm 345	2078 \pm 267	0.078
TOTAL PHYSICAL ACTIVITY	7439 \pm 616	5163 \pm 438	0.000*
TOTAL SITTING	3040 \pm 75	2567 \pm 72	0.000*

IPAQ items are explained in the legend of Table 4.3b (short IPAQ). Long IPAQ is divided into total moderate, vigorous, walking and sitting energy expenditure, regardless of whether it was performed at WORK, HOME, LTPA, or TRANS.

Table 4.4b. Total physical activity quartile cut-points for the long and short IPAQ.

Total physical activity (N = 81)	Quartile 1 METmin·wk⁻¹	Quartile 2 METmin·wk⁻¹	Quartile 3 METmin·wk⁻¹	Quartile 4 METmin·wk⁻¹
Long IPAQ	< 2145	2145 - 4050	4050 – 9345	> 9345
Short IPAQ	< 1485	1485 - 3240	3240 – 5670	> 5670

Table 4.4c. Chi-squared analysis on total physical activity quartiles for the long and short IPAQ.

	Short IPAQ Quartile 1	Short IPAQ Quartile 2	Short IPAQ Quartile 3	Short IPAQ Quartile 4	Row totals
Long IPAQ Quartile 1	12*	5	2	0	N = 19
Long IPAQ Quartile 2	6	12*	3	0	N = 21
Long IPAQ Quartile 3	2	1	11*	6	N = 20
Long IPAQ Quartile 4	0	1	5	15*	N = 21
	N = 20	N = 19	N = 21	N = 21	Total N = 81

*cells with counts > 10

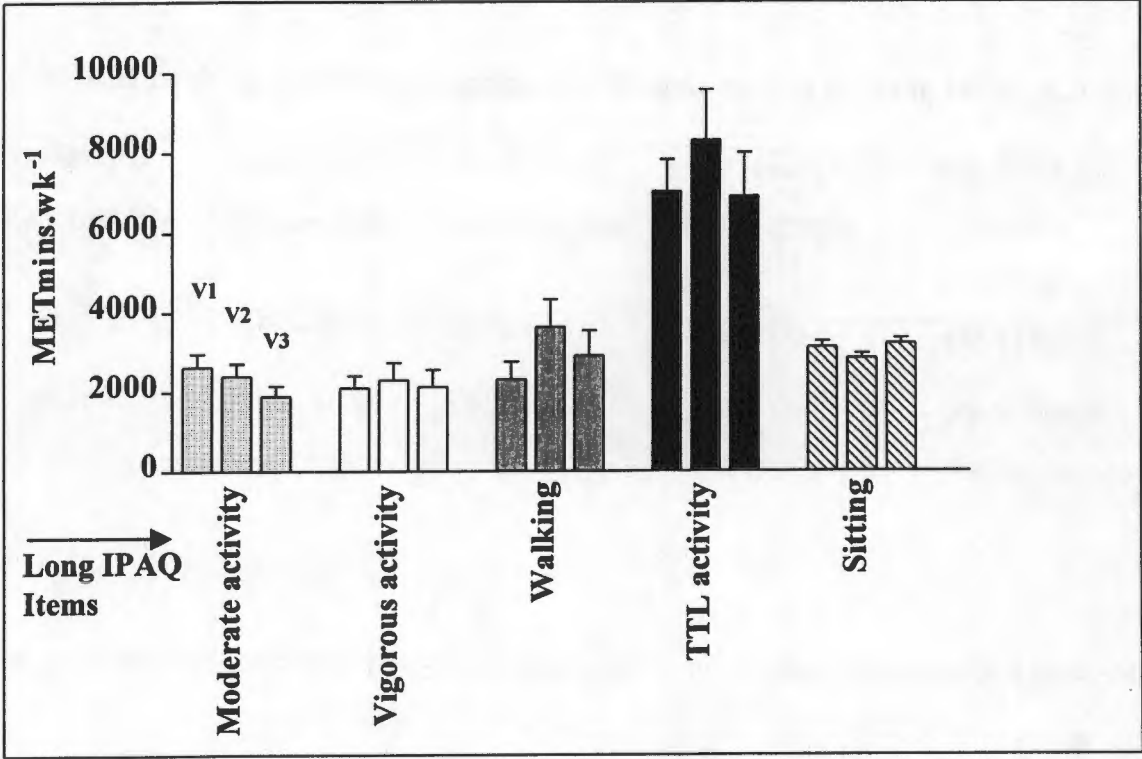


Figure 4.1. Energy expenditure (MET min·wk⁻¹) (\pm SEM) for the long IPAQ in visit one (V1), visit two (V2) and visit three (V3).

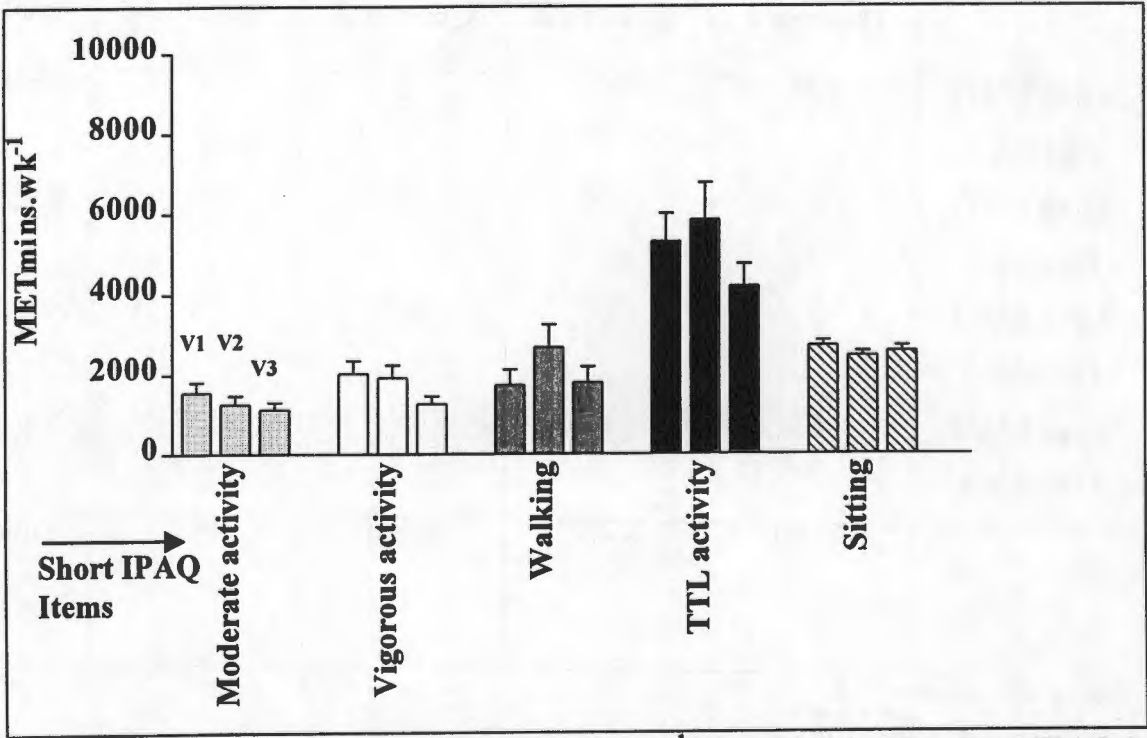


Figure 4.2. Energy expenditure (MET min·wk⁻¹) (\pm SEM) for the short IPAQ in visit one (V1), visit two (V2) and visit three (V3).

Table 4.5. Concurrent validity of the long IPAQ compared to the short IPAQ on the same administration.

IPAQ Variables		Spearman rank order correlation coefficients		
Short form (METmin·wk ⁻¹)	Long form (METmin·wk ⁻¹)	Visit One N = 81	Visit two N = 81	Visit three N = 67
Vigorous	Total vigorous	0.56	0.65	0.69
Moderate	Total moderate	0.53	0.80	0.70
Walking	Total walking	0.43	0.82	0.78
Total physical activity	Grand Total Physical Activity (GTPA, all sources)	0.79	0.83	0.87
Sitting	Sitting *	0.72	0.83	0.88
Sitting	Sitting #	0.70	0.80	0.83

Total vigorous = vigorous work + vigorous transport + vigorous leisure physical activity.

Total moderate = leisure time moderate + work moderate + home + moderate transport

Total walking = leisure time walking + transport walking + work walking

* = average sitting on week day + weekend day

= average sitting on week day + weekend day + time spent sitting during transport

Table 4.6. Spearman rank order correlation coefficients of the long IPAQ with variables measured in the study.

IPAQ Items	Physiological, biometrical and demographic variables					
	BMI ($\text{kg}\cdot\text{m}^{-2}$) N = 81	Predicted VO_2max $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ N = 78	% body fat N = 80	Age N = 81	Health N = 81	Education N = 81
WORK	0.091	-0.128	-0.031	-0.045	0.077	-0.249*
TRANS	0.001	-0.274*	0.165	-0.093	-0.097	-0.271*
HOME	0.224*	-0.177	0.202	0.171	0.267*	-0.278*
LTPA	-0.160	0.365**	-0.415***	-0.321**	-0.263*	0.243*
GTPA	0.118	-0.089	-0.070	-0.018	0.013	-0.266*
SITTING	-0.237*	0.176	-0.175	-0.114	0.129	0.342**
Total moderate physical activity	0.171	-0.130	0.026	0.202	0.030	-0.356**
Total vigorous physical activity	-0.133	0.328**	-0.368***	-0.222*	0.010	-0.458
Total walking	0.021	-0.226*	0.003	-0.156	-0.019	-0.185

BMI = body mass index. Health = rating of self-perceived health (ranging from 1 = excellent to 5 = poor).
 Education = number of years of formal education completed.
 PA = physical activity. IPAQ questionnaire items are explained in the legend of Table 4.2 and 4.4.
 (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table 4.7. Criterion validity: Long IPAQ energy expenditure compared to CSA Inc. activity monitor counts (N = 68).

Long IPAQ items (MET min·wk⁻¹)	CSA	r
Leisure Vigorous MET min.	Total High CSA Count	0.438***
Total Leisure MET min.	Total CSA Count	0.232
Total Leisure MET min.	Counts/registered time	0.311**
Total Leisure MET min.	Total Moderate+ High CSA	0.347**
Grand Total PA	Total CSA Count	0.480***
Grand Total PA	Counts/registered time	0.479***
Grand Total PA	Total Moderate + High CSA	0.465***
Total work MET min.	Total CSA Count	0.508***
Total work MET min.	Counts/registered Time	0.468***
Total work MET min.	Total Moderate + High CSA	0.465***
Total Transport	Total Moderate CSA	0.450***
Total Home	Counts/registered time	0.016
Total Vigorous Activity	Total Moderate and High CSA	0.440***
Total Vigorous Activity	Vigorous MET min.	0.352**
Total Vigorous Activity	Total high CSA counts	0.319**
Total Moderate Activity	Total moderate CSA METmin	0.487***

* P < 0.05, ** P < 0.01, *** P < 0.001. The average time the monitor was worn by the subject, minus any "zero counts" of 10 or more minutes, was considered the "registered time".

Table 4.8. Criterion validity: Short IPAQ energy expenditure compared to CSA activity monitor counts (N = 68).

Short IPAQ items (MET min·wk⁻¹)	CSA	r
Vigorous MET min.	High CSA Counts	0.186
Vigorous MET min.	Total CSA Counts	0.269*
Vigorous MET min.	Counts/registered time	0.325**
Vigorous MET min.	Total Moderate and High CSA	0.309**
Vigorous MET min.	Vigorous CSA MET min.	0.212
Vigorous MET min.	Moderate CSA MET min.	0.300*
Total PA MET min.	Total CSA Counts	0.311**
Total PA MET min.	Counts/registered time	0.333**
Total PA MET min.	Total Moderate and High CSA	0.321**
Walking MET min.	Moderate CSA MET min.	0.216
Moderate MET min.	Moderate CSA MET min.	0.213

* P < 0.05, ** P < 0.01, *** P < 0.001. The average time the monitor was worn by the subject, minus any "zero counts" of 10 or more minutes, was considered the "registered time".

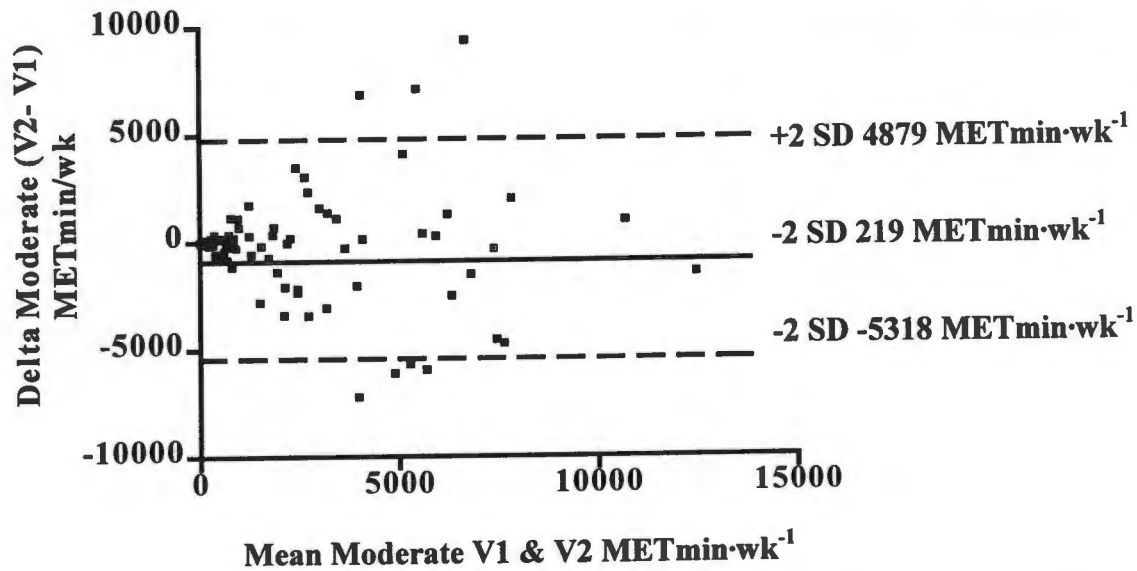


Figure 4.3. Limits of agreement for *moderate* physical activity in the *long* IPAQ on visit one (V1) and visit two (V2).

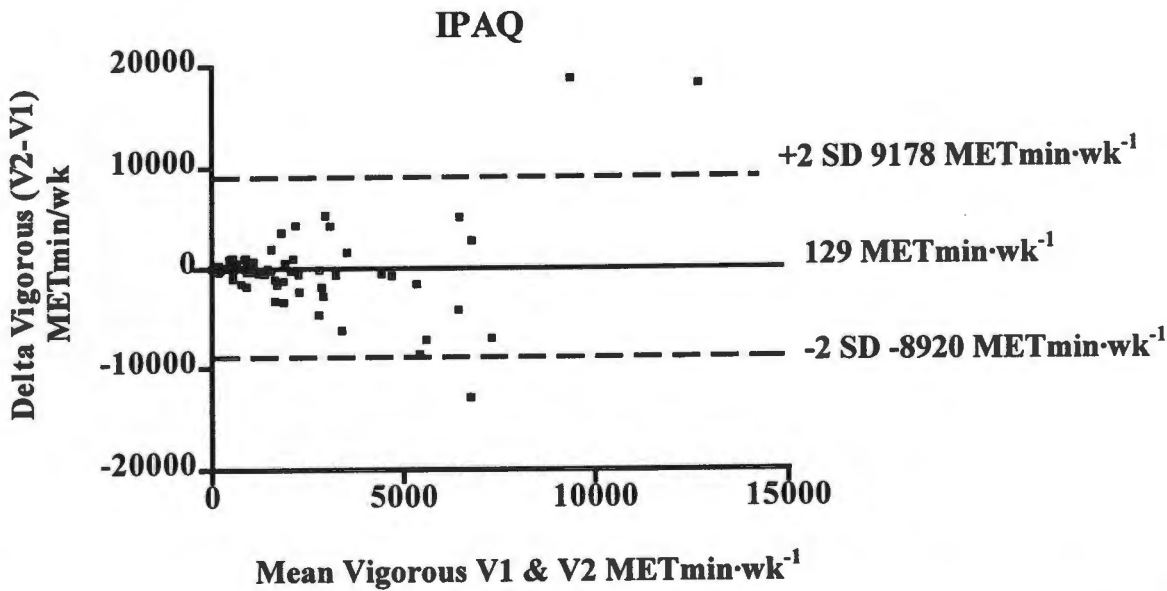


Figure 4.4. Limits of agreement for *vigorous* physical activity in the *long* IPAQ on visit one (V1) and visit two (V2).

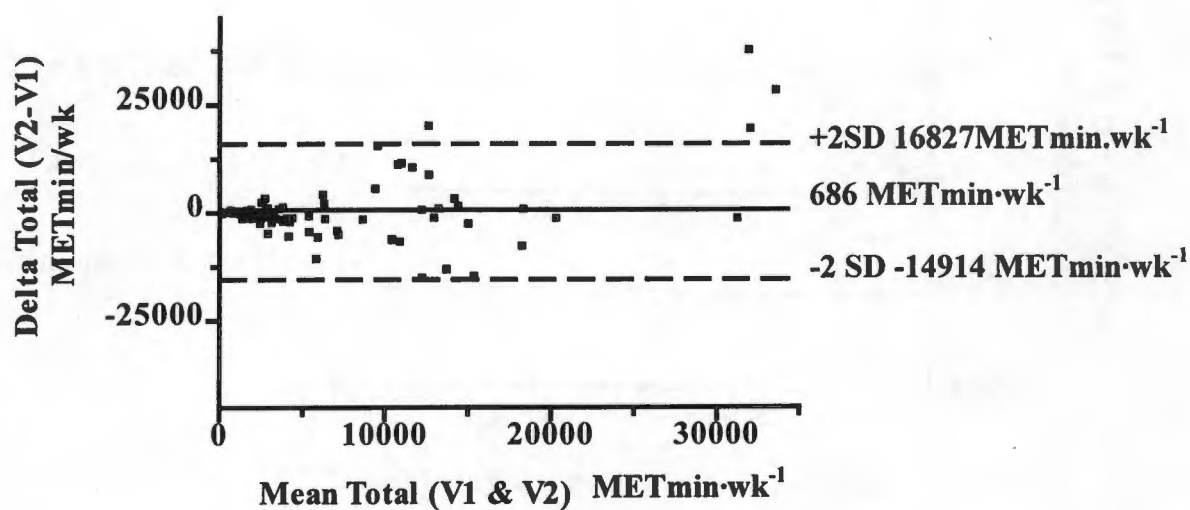


Figure 4.5. Limits of agreement for *total* physical activity in the *long* IPAQ on visit one (V1) and visit two (V2).

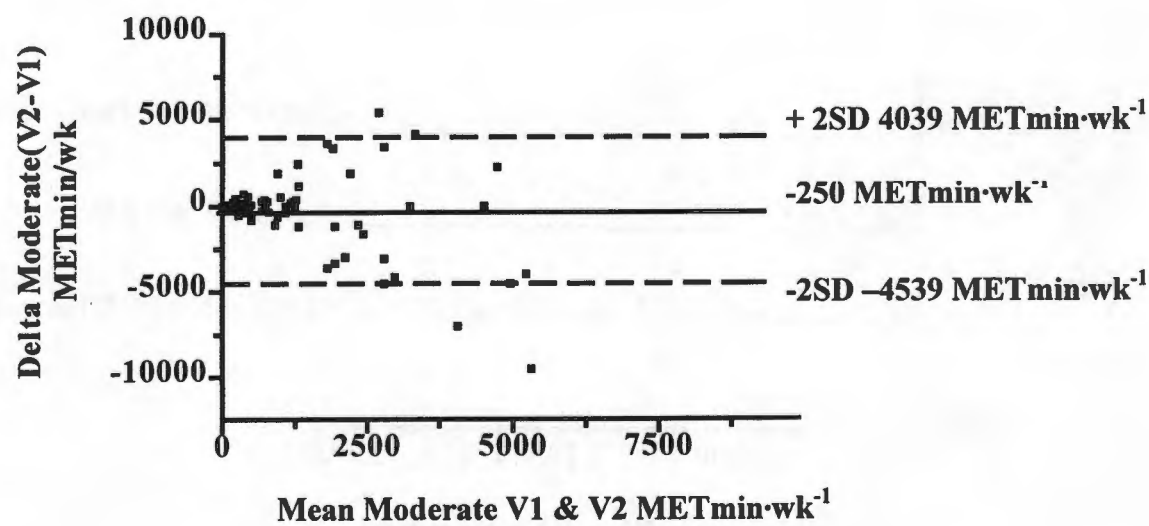


Figure 4.6. Limits of agreement for *moderate* physical activity in the *short* IPAQ on visit one (V1) and visit two (V2).

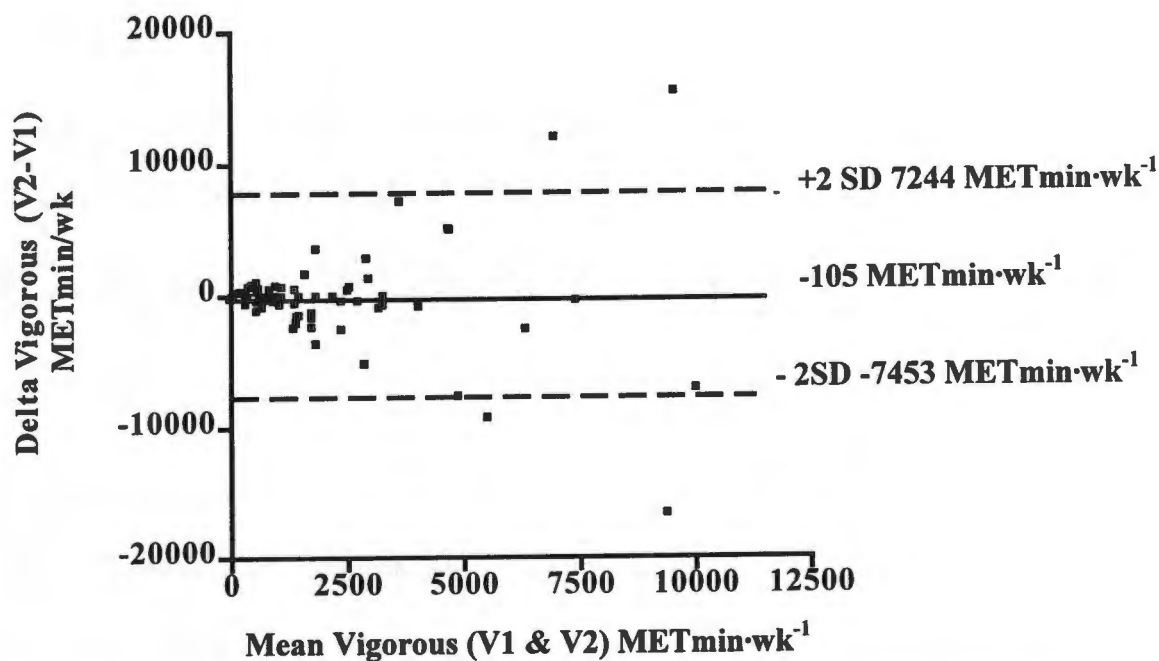


Figure 4.7. Limits of agreement for *vigorous* physical activity in the *short* IPAQ on visit one (V1) and visit two (V2).

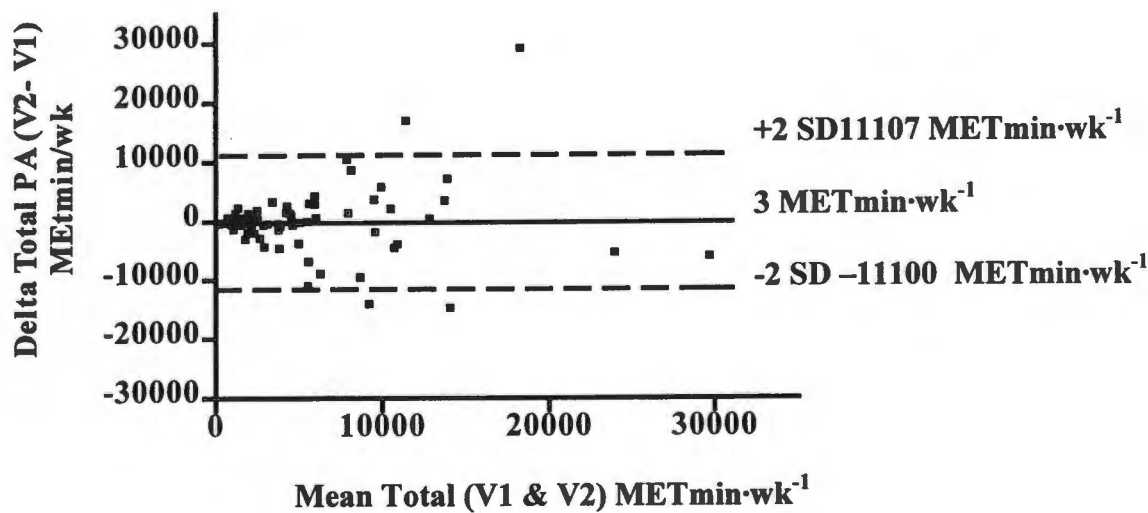


Figure 4.8. Limits of agreement for *total* physical activity in the *short* IPAQ on visit one (V1) and visit two (V2).

DISCUSSION

This study reports the validity and reliability of the IPAQ in an urban South African population. Overall, the long IPAQ and all its domains had acceptable test-retest reliability (Table 4.3c). In contrast, the short IPAQ had acceptable overall test-retest reliability, however MODERATE and VIGOROUS physical activity achieved only moderate test-retest reliability and the reliability of reported walking was generally poor (table 4.3d).

Our finding that walking is one of the least reliable activities reported is consistent with other studies(29;30). However, factors such as age, education, gender and housing density all played an important role in the reliability of reported walking in our study. More specifically, those subjects with less education (≤ 12 years), were more reliable between visits one and two for walking. Furthermore, no relationship was found between visits one and two for walking in males, subjects < 30 years of age and subjects with a lower housing density (< 1.5 persons per room).

When analyzing total physical activity, higher education, younger age and lower housing density all improved test-retest repeatability in the long and the short IPAQ. A higher housing density might be associated with lower socio-economic status and lower education, possibly resulting in less reliable self-report of physical activity. Another explanation might be that people with a higher income or socio-economic status were less physically active, resulting in a low variability in the parameters, which may have improved the correlations.

Reliability, measured by intraclass correlation coefficients was lower for moderate (household chores and transport related) activities than for occupational- and leisure time-related activities, which corroborates with the MOSPA¹ questionnaire used on a Flemish population (41) (**Table 4.9a**). This finding in the MOSPA study was explained by the fact that these activities are not always rigid, and consequently, are not easy to recall compared to intensive (e.g. LEISURE TIME PHYSICAL ACTIVITY) or structured activities (e.g. WORK).

The comparison of intra-class correlation coefficients between the short IPAQ and the 14 Day recall measure used in Australian adults (8) is seen in **Table 4.9b**. It is interesting to note that the same trend for total moderate activity in the Short IPAQ and the 14 Day recall. In both, total moderate activity had poor reliability and compared to the other domains, obtained the lowest intraclass correlation coefficients. Another similarity in both studies is that total vigorous activity obtained exactly the same intraclass correlation coefficients ($r = 0.67$). Rauh et al (40) studied the validity and reliability of six self-report measures in Latino adults, and also found the reporting of low to moderate activities to be less reliable. These findings however, could also indicate a greater day-to-day variability in low to moderate intensity physical activity.

Jacobs et al (1993) simultaneously evaluated ten commonly used physical activity questionnaires (26). They concluded that light and moderate activities were highly variable, and also noted the difficulty in defining and naming activities corresponding to these intensities, to create questionnaire references that accurately represent them. Sallis et al

(1985) used physical activity diaries to compare the ability of respondents to recall a broad spectrum of moderate, hard, and very hard activities on the Seven Day Recall physical activity questionnaire (42). While recall of hard and very hard activities was quite accurate, Sallis et al. found that recall of moderate activities was quite poor. This pattern was consistent in men and women and across leisure, occupation, home and conditioning activities.

Table 4.9a. Comparison between the long IPAQ and MOSPA intra-class correlation coefficients.

Physical activity domain	Intra-class correlation coefficient (ICC)	
	Long IPAQ	MOSPA* (41)
WORK	0.75	0.77
TRANS	0.56	0.68
HOME	0.38	0.55
LTPA	0.73	0.85
TOTAL Physical Activity	0.74	0.81

*The MOSPA questionnaire was developed by the World Health Organization for the MONICA (Monitoring trends and determinants of cardiovascular diseases) project. IPAQ item descriptions are found in table 4.2.

Table 4.9b. Comparison between the short IPAQ and 14 Day recall intra-class correlation coefficients.

Physical activity Domain	Intra-class correlation coefficient (ICC)	
	Short IPAQ	*14 Day Recall (8)
TOTAL MODERATE	0.32	0.55
TOTAL VIGOROUS	0.67	0.67
TOTAL WALKING	0.47	0.74
TOTAL PHYSICAL ACTIVITY	0.72	0.64

*14 Day Recall = Retest reliability study of recall measures of Leisure-time physical activity used in Australian adults (Booth, M. et al. 1996). IPAQ item descriptions are found in table 4.3b.

Another possible explanation for lack of good reliability in HOME and TRANSPORT, could be due to a social desirability bias (15). In some cases, when the questionnaires were administered, the subjects appeared embarrassed to admit that they did little, if any, housework and that they rarely walked from place to place, choosing rather to use a motor vehicle even for short distances. The interviewers were health professionals or sport scientists, which could also have put pressure subconsciously on the subjects to give socially desirable answers. Many subjects reacted by saying they were very busy, 'active' people because they were always up and down from their desks, in and out their motor vehicles and constantly occupied throughout the day. However, they failed to distinguish between being physically active (and achieving the related health benefits) and being hard-working. It seemed that subjects associated physical inactivity with laziness or being unproductive. It is important that the distinction between 'busyness' and 'physical activity' be clearly made, because the high-paced, stressful lifestyle that those who identify as being 'active', could actually have adverse health effects associated with physical inactivity.

It was expected that the reliability of visit two-three would be higher than that of visit one-two. This may be due to the subjects having more awareness of their daily activity or alternatively, as a result of a learning effect, especially because the time period between the visits were progressively shorter (visit one-two: 7 days apart vs. visit two-three: 4 days apart). Overall, the long IPAQ performed reasonably well, and except for transport and home, the intraclass correlation coefficients were all greater than $r = 0.70$, but below $r = 0.80$. In contrast, the short IPAQ intraclass correlation coefficients were all below $r = 0.70$,

except total physical activity ($r = 0.72$). The poor reliability of reporting moderate physical activity and walking compared to vigorous activities has also been found in other studies (26;40;44).

The magnitude of error between visit one and visit two can be seen graphically in figures 4.3 to 4.8. For the long IPAQ, moderate activity is less reliably reported with increasing levels of moderate physical activity. For vigorous activity, the same pattern is evident, however two subjects reported nearly 18 000 METmin·wk⁻¹ less vigorous activity than they had reported in visit one. This is equivalent to a “forgetting” or failing to report approximately seven hours of vigorous activity (6 MET) per day for seven days a week on a second visit—this seems highly unlikely. Possibly, the subjects involved realized that they had exaggerated the amount of vigorous physical activity they habitually engage in, and knowing that their fitness was going to be tested on the second visit, this caused them to report significantly less vigorous physical activity on the second administration of the IPAQ.

There was also a tendency for total activity to be over-reported with increasing levels of energy expenditure. For the short IPAQ, moderate activity seemed to be mostly under-reported with increasing levels of moderate physical activity. However, to put it into perspective again, on visit one, some subjects omitted up to 10 000 METmin·wk⁻¹, which is equivalent to 6 hours of moderate activity (4 MET) per day for seven days a week.

It was also evident that subjects tended to under- or over-report vigorous activity with increasing energy expenditure. Similarly, the Zutphen Questionnaire showed that as physical

activity increased, the consistency between scores decreased (37). Therefore, the divergent limits of agreement obtained in **figures 4.3 to 4.8** were not totally unexpected.

Validity. Tables 4.10a and 4.10b provide an overview of the correlation between IPAQ domains and validation criteria compared to similar studies. The highest correlations for the IPAQ were obtained between leisure time activities and cardiorespiratory fitness and body fatness. The correlations between the IPAQ item scores and validation criteria were in a similar range compared to other studies using similar criteria (26;40;41;44). The only exception to this was total physical activity (table 4.10a), which had below average correlations for cardiorespiratory fitness ($r = -0.09$ compared to $r = 0.39, 0.43, 0.54$ or 0.30 found in other studies). Cardiorespiratory fitness and body measurements have typically been used as a standard for validation of physical activity questionnaires, however, there is evidence that these measures reflect almost exclusively vigorous intensity activity (26), and therefore should not be used as the sole validation standards.

An unusual finding was that with increasing BMI there was an increase in HOME activity ($r = 0.224, P < 0.05$) and less time spent SITTING ($r = -0.237, P < 0.05$)(table 4.6). There was an inverse relationship between education and HOME activity ($r = -0.278, P < 0.05$). Furthermore, those subjects with less education spent significantly less time sitting at a desk, studying, etc ($r = -0.342, P < 0.01$) and possibly receive a lower income for their occupations. It is reasonable to assume that they would have to do their own housework, as opposed to employing someone to do it for them. Possibly, those subjects with a high BMI and less education had to spend more time at home, rather than participate in leisure time

physical activity. This can be explained by either the financial implications of recreational activities, or by their body size being an inhibiting factor. This theory is strengthened by the fact that those subjects who perceived themselves as having only fair or below average health, participated in significantly less LEISURE TIME PHYSICAL ACTIVITY ($r = -0.263$, $P < 0.05$) and more HOME activity ($r = 0.267$, $P < 0.05$).

Those subjects with higher education expended significantly less energy at WORK, TRANSPORT, HOME, and for their GRAND TOTAL PHYSICAL ACTIVITY and total moderate physical activity compared to those subjects with less education. However, those subjects with higher education spent more energy in LEISURE TIME PHYSICAL ACTIVITY and SITTING. This inverse association between LEISURE TIME PHYSICAL ACTIVITY and WORK has also been reported among middle-aged Japanese men and women (25) and higher socio-economic status men and women in Pennsylvania (18). This trend was expected in the current study, since those subjects with higher education would presumably be involved in more desk-bound occupations requiring considerably more sitting and therefore less WORK physical activity. Crespo et al (1999) also found an inverse association between physical inactivity and education (11). Their interpretation of this finding was that high educational attainment may be a reflection of a person's ability to understand and value the benefit of exercise for overall physical and psychological well-being. This is a plausible explanation for increased LEISURE TIME PHYSICAL ACTIVITY associated with higher levels of education, and may apply to this South African population.

The ability of the long and the short IPAQ to measure the same variable and achieve similar results, was determined by concurrent validity (**Table 4.5**). Usually a measure which is known to be validated and widely accepted is used as the criterion measure to compare results, however, the IPAQ has not yet been validated. The concurrent validity was high for total activity, which implies that these questionnaires have a good potential to be used interchangeably when looking at total energy expenditure. It must however be kept in mind that the limits of agreement between the long and the short (figures 4.3-4.8) show that with increasing energy expenditure, there is a tendency to over-report physical activity, especially for the long questionnaire. It should also be noted that moderate activity and walking obtained the weakest scores in the concurrent validity. This can be explained from the previous discussion on reliability.

Table 4.10a. Correlation coefficients between physical activity domains, determined by physical activity questionnaires, and cardiorespiratory fitness in this and other studies.

Physical activity domains	Cardiorespiratory fitness VO ₂ max (ml·kg·min ⁻¹)								
	IPAQ	MOSPA (41)	CARDIA (26;44)	HIP (26)	MLT (26)	BK (26)	7DR (26)	MHHP (26)	SUA (26)
WORK [⊖]	-0.13	0.21**	-	0.07	-	0.23	0.09	0.00	-
TRANS [⊖]	-0.27*	0.16*	-	-	-	-	-	-	-
HOME [⊖]	-0.18	-0.01	-	-	0.18	-	0.13	-	-
LTPA [⊖]	0.37**	0.30***	-	-	-	0.52 (sports) 0.26 (leisure)	-	0.56	-
TOTAL [⊖]	-0.09	0.39***	-	-	0.43	0.54	0.30	-	-
SITTING [⊖]	0.18	-	-	-	-	-	-	-	-
Total Moderate physical activity [⊖]	-0.13	-	0.08	-	0.15	-	0.19	-	0.27
Total vigorous physical activity [⊖]	0.33**	-	0.63	-	0.39	-	0.22	-	0.38

[⊖] Compared to the Long IPAQ. [⊖] Compared to the short IPAQ. All IPAQ questionnaire items are explained in the legend of Table 4.2 and 4.4.

(* P < 0.05, ** P < 0.01, *** P < 0.001). The MOSPA questionnaire was developed by the World Health Organization for the MONICA (Monitoring trends and determinants of cardiovascular diseases) project. CARDIA= 'Coronary Artery Risk Development in Young Adults' Physical Activity History Questionnaire, HIP = Health Insurance Plan of New York Work, MLT= Minesota Leisure Time Questionnaire, BK= Baecke, 7DR= Seven Day Recall, MHHP= Minesota Heart Health Programme, SUA= Stanford Usual Activity.

Table 4.10b. Correlation coefficients between physical activity domains, determined by physical activity questionnaires, and BMI and body fatness, in this and other studies.

Physical activity domains	BMI (kg·m ⁻²)		% Body Fat								
	IPAQ (long)	MOSPA (41)	IPAQ (long)	MOSPA (41)	GLT (26)	MHHP (26)	LRC (26)	HIP (26)	MLT (26)	BK (26)	7DR (26)
WORK	0.09	0.08	-0.03	-0.17*	-	0.07	-	-0.03	-	-0.17	0.05
TRANS	0.00	-0.17*	0.17	-0.13	-	-	-	-	-	-	-
HOME	0.22*	-0.15	0.20	-0.01	-	-	-	-	-0.08	-	0.05
LTPA	-0.16	0.04	-0.42***	-0.25	-0.43	-0.37	-	-	-	-0.37	-0.03 (moderate) -0.12 (vigorous)
TOTAL	0.12	0.30***	-0.07	-0.26***	-	-	-0.43	-	-0.24	-0.49	-0.12

BMI = body mass index. IPAQ questionnaire items are explained in the legend of Table 4.2 and 4.4.

(* P < 0.05, ** P < 0.01, *** P < 0.001). The MOSPA questionnaire was developed by the World Health Organization for the MONICA (Monitoring trends and determinants of cardiovascular diseases) project. GLT= Godin Leisure Time. MHHP= Minnesota Heart Health Programme. LR= Lipid Research Clinic, HIP = Health Insurance Plan of New York Work. MLT= Minnesota Leisure Time Questionnaire. BK= Baecke. 7DR= Seven Day Recall.

Further evidence for concurrent validity of the long and short IPAQ was demonstrated by subjects classified in the lowest quartile of physical activity for the short IPAQ being significantly more likely to be classified similarly in the long IPAQ (Table 4.4c). This occurred in 60% of the cases. Similarly, if a subject was classified in the most active quartile for the long IPAQ, he/she was classified in the same quartile for the short IPAQ in 71% of the cases. If subjects are to be classified into sedentary and active categories for example when studying health risks, then this finding is important for accurate classification regardless of whether the long or short IPAQ is used. It is also important to mention that it was expected that the long IPAQ would yield higher levels of energy expenditure, as it had a greater number of responses which could yield energy expenditure data.

The criterion validity for total leisure activity and total CSA counts was low (Table 4.7). This was expected, as in this population, leisure time physical activity did not constitute the majority of energy expenditure. Instead, occupational, household and transport related physical activity contributed significantly to total energy expenditure (Table 4.2). Another explanation for low validity for LTPA, may be that approximately 15% of subjects participated in water sports, such as windsurfing, swimming and surfing. This meant their leisure time physical activity was not recorded by the CSA as it had to be removed in water. The subjects who participated in resistance training would also have expected low criterion validity for LTPA, because the movement of lifting a weight is slow and small as opposed to another vigorous activity such as jogging. Therefore this would have been recorded as a light activity on the CSA, although this exercise is strenuous and requires considerable effort. Despite these limitations, the correlations between IPAQ items and the accelerometer were comparable to the results of other physical

activity questionnaires (**Table 4.11**). In this comparison it can be seen that, LTPA and total moderate and vigorous activity had higher validity compared to other studies.

It was interesting to note that the men in this study worked longer hours compared to women, and yet they managed to engage in nearly twice as much leisure time physical activity compared to women (**Table 4.2**). The disparities in these results can be attributed to a cultural phenomenon or perhaps a problem with the assessment of physical activity between men and women. The finding that women are considerably less active than men is not unique to South Africa, as other studies have also found these differences (12;25;39;41). However, it has been suggested that these differences could be a real phenomenon, or the result of a consistently reported artifact in assessing physical activity in women (39). This problem can be explained by the fact that women engage in more light-to-moderate activities (35;42), which are neither easily remembered or categorized. This makes these activities difficult to measure (28), explaining why the amount of physical activity that women engage in is frequently under-reported.

Table 4.11. Correlations between physical activity domains determined by physical activity questionnaires and average accelerometer counts.

Physical activity domains	Accelerometer counts										
	IPAQ	PIMA (29)	NHIS (40)	G-S (40)	CARDIA (26;44)	HIP (26)	MLT (26)	BK (26) (40)	7DR (26) (40)	MHHP (26)	SUA (26)
WORK[⊞]	0.51***	0.41				0.14		0.11 (26) 0.42*(40)	0.10 (26)	0.04	
TRANS[⊞]	0.45***										
HOME[⊞]	0.02						0.03				
LTPA[⊞]	0.44***	0.69*						0.32 (26) 0.39*(40)(sport) 0.01 (26) 0.41*(40)(leisure)		0.28	
TOTAL[⊞]	0.48**	0.59*		0.35*			0.18	0.19	0.33 (26) 0.57*(40)		
Total moderate physical activity[⊞]	0.49***			0.13	0.11		0.22		0.17 (26) 0.38*(40)		0.23
Total vigorous physical activity[⊞]	0.44***			0.34*	0.31		0.16		0.26 (26) 0.28*(40) 0.43* very hard (40)		0.22
Walking[⊞]	0.22		0.33								

[⊞] Compared to the Long IPAQ. [⊞] Compared to the short IPAQ. IPAQ questionnaire items are explained in the legend of Table 4.2 and 4.4. (When available: * P < 0.05, ** P < 0.01, *** P < 0.001) PIMA= Questionnaire developed for Diabetes research Pima Indians. NHIS= National Health Interview Survey on walking, G-S= Godin- Shepard Survey, CARDIA= 'Coronary Artery Risk Development in Young Adults' Physical Activity History Questionnaire, HIP= Health Insurance Plan of New York Work. MLT= Minnesota Leisure Time Questionnaire. BK =Baecke, 7DR= Seven Day Recall, MHHP= Minnesota Heart Health Programme..., SUA= Stanford Usual Activity.

CONCLUSION

The validity and reliability of the long and short version of the IPAQ were found to be acceptable for urban, middle-aged adults in this South African sample. This questionnaire is easy to administer to large numbers of subjects at minimal cost and burden to the subject. Furthermore, the long IPAQ has the advantage of being comprehensive as it probes occupational-, transport-, household- and leisure time physical activity. This is particularly meaningful when physical activity patterns and chronic diseases of lifestyle are being researched, as it identifies possible areas of intervention. Some categories of physical activity however, exhibited high within-subject variation. For example, moderate activities and walking in particular, showed low reliability and validity. Further investigations should be made on these less stable activities in order to establish effective ways to measure them accurately. There was also evidence to suggest that demographic variables, such as education, age, gender and housing density may play an important role in the reliability of the IPAQ.

The long and short IPAQ, has similar validity and reliability in this South African group compared to other studies using physical activity questionnaires. These data indicate that the IPAQ has adequate levels of validity and reliability for the assessment of physical activity in epidemiological studies, despite its apparent limitations. In summary, the IPAQ has the potential to be a useful tool to compare physical activity patterns between different populations and cultures. This study provides the opportunity for further national and international research on the prevalence of physical activity, as well as research on the measurement of physical activity “dose” across cultures.

References

1. Berlin, J. A. and G. A. Colditz. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol.* 132: 612-628, 1990.
2. Bijnen, F. C. H., C. J. Caspersen, and W. L. Mosterd. Physical inactivity as a risk factor for coronary heart disease: a WHO and International Society and Federation of Cardiology position statement. *Bulletin of the World Health Organisation* 72: 1-4, 1994.
3. Blair, S. N. and S. Brodney. Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Med Sci Sports Exerc.* 31: S646-S662, 1999.
4. Blair, S. N., W. L. Haskell, P. Ho, R. S. Paffenbarger, Jr., K. M. Vranizan, J. W. Farquhar, and P. D. Wood. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol.* 122: 794-804, 1985.
5. Bland, J. M. and D. G. Altman. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1: 307-310, 1986.
6. Bohlmann, I. M. T., Lambert, E. V., and Lambert, M. I. Self selected 'moderate' and 'vigorous' walking pace and relative intensity: understanding perception of effort. [In review].

7. Booth, M., Jones, D., and Ainsworth, B. E. Workshop on the International Standardization of Physical Activity Assessment for Public Health Purposes. Methods of assessing the repeatability and validity of self-report measures of physical activity participation: A discussion paper by the International Physical Activity Questionnaire (IPAQ) Executive. 1999.
8. Booth, M. L., N. Owen, A. E. Bauman, and C. J. Gore. Retest reliability of recall measures of leisure-time physical activity in Australian adults. *Int J Epidemiol.* 25: 153-159, 1996.
9. Charlton, K. E., E. V. Lambert, and J. Kreft. Physical activity, change in blood pressure and predictors of mortality in older South Africans-a 2-year follow-up study. *S Afr Med J* 87: 1124-1130, 1997.
10. Colditz, G. A. Economic costs of obesity and inactivity. *Med Sci Sports Exerc.* 31: S663-S667, 1999.
11. Crespo, C. J., B. E. Ainsworth, S. J. Keteyian, G. W. Heath, and E. Smit. Prevalence of physical inactivity and its relation to social class in U.S. adults: results from the Third National Health and Nutrition Examination Survey, 1988-1994. *Med Sci Sports Exerc.* 31: 1821-1827, 1999.
12. de Bourdeaudhuij, I and P. van Oost. A cluster-analytical approach toward physical activity and other health related behaviors. *Med Sci Sports Exerc.* 31: 605-612, 1999.

13. DiPietro, L. Physical activity, body weight, and adiposity: an epidemiologic perspective. *Exerc.Sport Sci Rev.* 23: 275-303, 1995.
14. Dowse, G. K., H. Gareeboo, M. M. Alberti, P. Z. Zimmet, J. Tuomilehto, A. Purran, D. Fareed, P. Chitson, V. R. Collins, and F. Hemraj. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. *Br Med J* 311: 1255-1259, 1995.
15. Durante, R. and B. E. Ainsworth. The recall of physical activity: using a cognitive model of the question-answering process. *Med Sci Sports Exerc.* 28: 1282-1291, 1996.
16. Durnin, J. and V. Rahaman. The assessment of the amount of fat in the human body from measurements on 481 men and women aged 16-72 years. *Br J Nurt* 32: 77-97, 1974.
17. Farahmand, B. Y., P. G. Persson, K. Michaelsson, J. A. Baron, A. Alberts, T. Moradi, and S. Ljunghall. Physical activity and hip fracture: a population-based case-control study. Swedish Hip Fracture Study Group. *Int J Epidemiol.* 29: 308-314, 2000.
18. Ford, E. S., R. K. Merritt, and G. W. Heath. Physical activity behaviors in lower and higher socio-economic status populations. *Am J Epidemiol.* 133: 1246-1256, 2000.
19. Freedson, P. S., E. Melanson, and J. Sirard. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc.* 30: 777-781, 1998.

20. Golding, L. A., C. R. Meyers, and W. E. and Sinning. Y's way to Physical Fitness: The complete guide to fitness testing and instruction. Champaign, Human Kinetics. 1989, 276-278.
21. Haapanen, N., S. Miilunpalo, I. Vuori, P. Oja, and M. Pasanen. Association of Leisure Time Physical Activity with the Risk of Coronary Heart Disease, Hypertension and Diabetes in Middle-Aged men and Women. *Int J Epidemiol* 26: 739-747, 1997.
22. Hallqvist, J., J. Moller, A. Ahlbom, F. Diderichsen, C. Reuterwall, and U. de Faire. Does heavy physical exertion trigger myocardial infarction? A case- crossover analysis nested in a population-based case-referent study. *Am J Epidemiol*. 151: 459-467, 2000.
23. Haskell, W. L., M. C. Yee, A. Evans, and P. J. Irby. Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Med Sci Sports Exerc*. 25: 109-115, 1993.
24. Helmrich, S. P., D. R. Ragland, R. W. Leung, and R. S. Paffenbarger, Jr. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 325: 147-152, 1991.
25. Iwai, N., N. Yoshiike, S. Saitoh, T. Nose, and H. Tanaka. Leisure-time physical activity and related lifestyle characteristics among middle-aged Japanese. Japan Lifestyle Monitoring Study Group. *Epidemiology* 10: 226-233, 2000.

26. Jacobs, D. R., Jr., B. E. Ainsworth, T. J. Hartman, and A. S. Leon. A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Med Sci Sports Exerc.* 25: 81-91, 1993.
27. Johansson, S. E. and J. Sundquist. Change in lifestyle factors and their influence on health status and all-cause mortality. *Int J Epidemiol.* 28: 1073-1080, 1999.
28. King, A. C., S. N. Blair, D. E. Bild, R. K. Dishman, P. M. Dubbert, B. H. Marcus, N. B. Oldridge, R. S. Paffenbarger, Jr., K. E. Powell, and K. K. Yeager. Determinants of physical activity and interventions in adults. *Med Sci Sports Exerc.* 24: S221-S236, 1992.
29. Kriska, A. M., W. C. Knowler, R. E. LaPorte, A. L. Drash, R. R. Wing, S. N. Blair, P. H. Bennett, and L. H. Kuller. Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care* 13: 401-411, 1990.
30. Kriska, A. M., R. B. Sandler, J. A. Cauley, R. E. LaPorte, D. L. Hom, and G. Pambianco. The assessment of historical physical activity and its relation to adult bone parameters. *Am J Epidemiol.* 127: 1053-1063, 1988.
31. Lee, I.M., K.M. Rexrode, N.R. Cook, J.E. Manson, and J.E. Buring. Physical Activity and Coronary Heart Disease in Women Is "No Pain, No Gain" Passé? *JAMA* 285: 1447-1454, 2001.

32. Lee, I. M. and R. S. Paffenbarger, Jr. Do physical activity and physical fitness avert premature mortality? *Exerc Sport Sci Rev.* 24: 135-171, 1996.
33. Manson, J. E., D. M. Nathan, A. S. Krolewski, and M. J. Stampfer. A Prospective Study of Exercise and Incidence of Diabetes Among US Male Physicians. *JAMA* 268: 63-67, 1992.
34. McMurray, R. G., B. E. Ainsworth, J. S. Harrell, T. R. Griggs, and O. D. Williams. Is physical activity or aerobic power more influential on reducing cardiovascular disease risk factors? *Med Sci Sports Exerc.* 30: 1521-1529, 1998.
35. Mensink, G. B. Intensity, duration, and frequency of physical activity and cardiac risk factors. *Med Sci Sport Exerc.* 29: 1192-1198, 1997.
36. Miller, G. J., G. H. Maude, and G. L. Beckles. Incidence of hypertension and non-insulin dependent diabetes mellitus and associated risk factors in a rapidly developing Caribbean community: the St James survey, Trinidad. *J Epidemiol Community Health* 50: 497-504, 1996.
37. Montoye, H. J. Measuring physical activity and energy expenditure. Champaign, Illinois, Human Kinetics. 1996.
38. Pate, R. R., M. Pratt, S. N. Blair, W. L. Haskell, C. A. Macera, C. Bouchard, D. Buchner, W. Ettinger, and et al. Physical Activity and Public Health. A recommendation From the

CHAPTER FIVE

CONCLUSION OF THIS THESIS AND SPECIFIC RECOMMENDATIONS FOR FUTURE RESEARCH

The aim of this thesis was firstly to establish how accurately subjects distinguish between moderate and vigorous intensity levels, using walking as an example of a physical activity and heart rate as an indication of intensity. The effect of age, language, education and gender on the perception of what a moderate and vigorous physical activity constitutes was of primary interest. Once subject's perception of intensity of habitual physical activity was determined, the second aim of this thesis was to determine (with the use of accelerometry as a validation tool) whether the International Physical Activity Questionnaire (IPAQ), which is designed to measure moderate and vigorous intensity activity, is a valid and reliable physical activity measurement tool in South Africa.

An aim of physical activity epidemiologists is to identify the level of physical activity that is sufficient to have a 'protective' effect for various chronic diseases of lifestyle. Recent evidence has shown that there is a difference on the effect that light, moderate and vigorous physical activity has on risk factors for chronic disease (1;2). Therefore it is important to clarify these differences in physical activity intensity, as the application of these findings may have important public health consequences.

From my study in chapter three, it was found that subjects could accurately differentiate absolute and relative walking intensities and understood what was meant by the terms 'moderate' and 'vigorous'. However, absolute pace and relative intensity may vary according to differences in gender, fitness, age, height, body fat % and habitual levels of vigorous activity. These significant factors warrant further research for the establishment of physical activity guidelines which can be established, taking these individual differences into account.

This thesis highlights the importance of the standardization of terminology used to describe intensity in physical activity questionnaires, as this is crucial for the accurate measurement of physical activity across populations. The lack of association between low intensity physical activity and mortality rates shown, for example by Lee et al. (2000), could either be a real phenomenon, or the inability of the physical activity questionnaire used to detect light physical activity (1), as it is known that low and moderate intensity activities are difficult to recall and measure compared to vigorous activities. The answer to this question is important, as it may be easier to mobilize a population into low or moderate intensity physical activity, especially in a predominantly sedentary society, than vigorous activity.

Ongoing efforts to improve the validity and reliability of the measurement of physical activity by self-report will enable cross-cultural and international comparisons to examine secular trends. It is a challenging, yet inevitable task to devise a questionnaire that can be

accurately used across cultures and populations. The International Physical Activity Questionnaire (IPAQ) was designed for this purpose.

The results from chapter four of this thesis showed that the IPAQ has acceptable reliability and validity in an urban living sample from the South African population, for the assessment of physical activity in epidemiological studies. The long and short IPAQ, has similar validity and reliability in this South African group compared to other studies using physical activity questionnaires. One of the strengths of this study was the diversity of subjects recruited, who represented a wide range of socioeconomic backgrounds. The IPAQ has the potential to be a useful tool to compare physical activity patterns between different populations and cultures. This study provides the opportunity for further national and international research on the prevalence of physical activity, as well as research on the measurement of physical activity “dose” across cultures.

References

1. Lee, I. M. and R. S. Paffenbarger, Jr. Associations of light, moderate, and vigorous intensity physical activity with longevity. The Harvard Alumni Health Study. *Am J Epidemiol.* 151: 293-299, 2000.
2. Mensink, G. B. Intensity, duration, and frequency of physical activity and cardiac risk factors. *Med Sci Sport Exerc.* 29: 1192-1198, 1997.

APPENDIX 1: ABSTRACTS RESULTING FROM THIS THESIS

PUBLISHED:

The South African Journal of Sports Medicine (6) : 22-23 (Suppl September 1999)

PAPERS PRESENTED:

1. *8th Biennial Congress of the South African Sports Medicine Association September 1999*
2. *All Africa Games Scientific Congress Sept 1999*

Comparison between short and long version of the international physical activity questionnaire

ISABELLE M.T. BOHLMANN and ESTELLE V. LAMBERT

Bioenergetics of Exercise Research Unit of the Medical Research Council and the University of Cape Town, South Africa.

ABSTRACT

Aims and methods: A working group from the World Health Organization in conjunction with the Centre of Disease Control, USA, recently developed a prototype international physical activity questionnaire (IPAQ) for the purpose of cross-cultural comparison of physical activity (PA) for public health purposes. Short and long versions were compiled. The long version categorized PA into four domains: occupational, transport, household and leisure. The aim of this study was to compare the direction and limits of agreement for moderate, vigorous and total energy expenditure (MET-hrs/wk) in a small convenience sample ($N=34$, $X=37.5 \pm 11.1$ yr). The mean $\dot{V}O_2$, fat % and BMI were 35.4 ± 12.9 ml O_2 /kg/min, $27.6 \pm 9.1\%$ and 26.7 ± 4.8 respectively. Males ($n=14$) and females ($n=20$). The PA questionnaires were administered in a randomized order within one week of each other.

Results: There was significant correlation between moderate energy expenditure (EE) ($r=0.72$, $p<0.001$), vigorous EE ($r=0.85$, $p<0.001$) and total EE ($r=0.79$, $p<0.001$). However, there were poor limits of agreement for moderate activity between the long and the short IPAQ. There was a mean difference of 13.5 ± 29.4 MET-hrs/wk of moderate activity between the long and short IPAQ. This difference increased significantly with increasing levels of activity ($r=0.71$, $p<0.001$). There was however good agreement between questionnaires for vigorous EE; the mean difference was 1.4 ± 6.1 MET-hrs/wk. Gender, education, language or $\dot{V}O_2$ could not explain the differences in EE based on the long and short IPAQ in this small pilot study. **Conclusions:** While EE predicted using the long or short IPAQ are highly correlated, there is poor agreement in absolute moderate and total EE between the two techniques. These preliminary data suggest i) that the tools may not be able to be used interchangeably and ii) that moderate activity is predicted with poor accuracy.

Self selected moderate and vigorous walking pace, heart rate and relative intensity: implications for physical activity questionnaires

ISABELLE M. T. BOHLMANN, ESTELLE V. LAMBERT, MICHAEL I. LAMBERT

MRC/UCT Bioenergetics of Exercise Research Unit, University of Cape Town Medical School, South Africa, Sports Science Institute of South Africa, Private Bag X5, Newlands, 7725.

ABSTRACT

Physical activity questionnaires are dependent on self-reported levels of moderate and vigorous activity, which may be confounded by individual and cultural perceptions of relative exercise intensity, fitness, and habitual levels of activity. Aim: The aim of the present study was to examine self-selected walking pace, corresponding to 'moderate' and 'vigorous' activity, and to determine factors that may be associated with differences in walking pace at similar relative intensities. Methods: A convenience sample of 63 women and 39 men were recruited. On the first visit, maximal oxygen consumption (VO_2max) was estimated from a validated 2km walking test, and fat % was estimated from the sum of 4 skinfolds. Within 1 week of initial testing, subjects were asked to walk for 6 min on an indoor track at a pace they regarded as 'moderate'. After completing this stage, subjects rested until heart rate had returned to pre-exercise levels, after which they were asked to walk at a pace they considered 'vigorous'. Investigators determined walking speed and heart rate at each intensity, and subjects were not informed of their speed or distance. Habitual levels of physical activity were estimated using a prototype physical activity questionnaire. Results: Mean self-selected walking pace for moderate activity levels was 5.54 km/hr (95% C.I.: 5.40; 5.69), and corresponded to 58% of age-predicted maximum heart rate ($\%\text{HR}_{\text{max}}$). Mean self-selected vigorous pace was 7.03 km/hr (95% C.I.: 6.85; 7.20), at 71.7% HR_{max} (95% C.I.: 69.3; 74.0). The only significant predictor of moderate pace was VO_2max ($r = 0.47$, $P < 0.001$). However, multivariate analysis revealed that vigorous pace was positively associated with VO_2max ($P < 0.00001$) and habitual levels of vigorous activity ($P < 0.054$), and negatively associated with % body fat ($P < 0.018$), age ($P < 0.018$) and gender (lower in women, $P < 0.0015$). % HR_{max} for both moderate and vigorous pace were inversely associated with VO_2max ($r = -0.54$, $P < 0.001$, $r = -0.33$, $P < 0.001$). Conclusions: These results suggest that self-reporting of moderate and vigorous physical activity levels are dependent on fitness/ VO_2 , habitual levels of vigorous activity, age and body fat levels. This has implications for the assessment of physical activity levels for public health purposes.

Key words: PHYSICAL ACTIVITY, MODERATE, VIGOROUS, EXERTION, QUESTIONNAIRE.

APPENDIX A: ADVERTISEMENT

The World Health Organisation (WHO) needs you for important research being conducted on physical activity...

All you need to do is come to the Sport Science Institute. We will calculate your fat percentage (using skinfolds) and your fitness level (by a simple walking test). On a separate day you will be required to walk for a few minutes with a heart rate monitor on and answer a quick questionnaire.

You do NOT have to be physically fit to participate in this study. We need:

- **75 subjects**
- **between the ages of 21-55 years**
- **male or female**
- **Any language and culture**
- **Any shape and size**

No blood or pain involved! You get a free Sport Science water bottle on completion. Your assistance will be helping to improve the quality of life of millions of South Africans.

Subjects were recruited from the following companies:

- **South African Breweries**
- **Fedsure**
- **Woolworths**
- **Pick and Pay**
- **Newlands Healthcare Centre**
- **Cape Town College of Education**

(Staff, students and ground/maintenance staff)

- **Sport Science Institute of South Africa**

(Cleaners, security, Fitness Center members, staff etc)

Centers for Disease Control and Prevention and the American College of Sports Medicine.
JAMA 273: 402-407, 1995.

39. Pereira, M. A., A. M. Kriska, M. L. Joswiak, G. K. Dowse, V. R. Collins, P. Z. Zimmet, H. Gareeboo, P. Chitson, F. Hemraj, and A. Purran. Physical inactivity and glucose intolerance in the multiethnic island of Mauritius. *Med Sci Sports Exerc.* 27: 1626-1634, 1995.
40. Rauh, M. J., M. F. Hovell, C. R. Hofstetter, J. F. Sallis, and A. Gleghorn. Reliability and validity of self-reported physical activity in Latinos. *Int J Epidemiol.* 21: 966-971, 1992.
41. Roeykens, J., R. Rogers, R. Meeusen, L. Magnus, J. Borms, and K. de Meirleir. Validity and reliability in a Flemish population of the WHO-MONICA Optional Study of Physical Activity Questionnaire. *Med Sci Sports Exerc.* 30: 1071-1075, 1998.
42. Sallis, J. F., W. L. Haskell, P. D. Wood, S. P. Fortmann, T. Rogers, S. N. Blair, and R. S. Paffenbarger, Jr. Physical activity assessment methodology in the five-city project. *Am J Epidemiol.* 121: 91-106, 1985.
43. Sarkin, J. A., J. F. Nichols, J. F. Sallis, and K. J. Calfas. Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Med Sci Sports Exerc.* 32: 149-156, 2000.

44. Sidney, S., D. R. Jacobs, Jr., W. L. Haskell, M. A. Armstrong, A. Dimicco, A. Oberman, P. J. Savage, M. L. Slaterry, B. Sternfeld, and L. Van Horn. Comparison of two methods of assessing physical activity in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Epidemiol.* 133: 1231-1245, 1991.
45. Srivastava, A. and N. Kreiger. Relation of physical activity to risk of testicular cancer. *Am J Epidemiol.* 151: 78-87, 2000.
46. Steyn, K., J. Fourie, and D. Bradshaw. The impact of chronic diseases of lifestyle and their major risk factors on mortality in South Africa. *S Afr Med J* 82: 227-231, 1992.
47. Steyn, K., J. E. Rossouw, P. L. Jooste, D. O. Chalton, E. R. Jordaan, P. C. Jordaan, M. Steyn, and A. S. Swanepoel. The intervention effects of a community-based hypertension control programme in two rural South African towns: the CORIS Study. *S Afr Med J* 83: 885-891, 1993.
48. Taylor, R., J. Badcock, H. King, K. Pargeter, P. Zimmet, T. Fred, M. Lund, H. Ringrose, F. Bach, and R. L. Wang. Dietary intake, exercise, obesity and noncommunicable disease in rural and urban populations of three Pacific Island countries. *J Am Coll Nutr.* 11: 283-293, 1992.
49. Vincent, W. J. Statistics in Kinesiology. Human Kinetics, Champaign, IL. 1995, 167-182.

APPENDIX B: SUBJECT INFORMATION AND INFORMED CONSENT

SUBJECT INFORMATION

This study, conducted at the Sport Science Institute of South Africa, is investigating cultural perception of moderate and vigorous activity.

The following measurements/tests will be performed:

***Anthropometry:* weight, height, waist circumferences**

***Standard 6 minute walk test:* Two walk tests conducted on the track. Subject will be required to walk one at a moderate pace and the other at a vigorous pace.**

***Heart rate:* A Polar heart rate monitor will be worn around the chest.**

***Physical activity questionnaire:* The modified version of the International Physical Activity Questionnaire proposed by the WHO will be administered.**

Test two: A 2km walk test to measure predicted oxygen consumption.

INFORMED CONSENT FORM

I, the undersigned, voluntarily agree to participate in this study. I will be free to withdraw from the study at any moment, without having to justify my decision. I will be free to ask any questions about the procedures and results of the study.

The risks will not be more than those associated with moderate and vigorous supervised exercise. All efforts will be made to minimize risks through appropriate screening and supervision.

I understand the results of the research study may be published, but that my name or identity will not be revealed under any circumstances, and complete confidentiality will be maintained.

I, the undersigned, have read and understood the purposes and procedures involved in the scientific study.

Subject name: _____

Signature: _____ **Date:** _____

Investigator: _____

Signature: _____ **Date:** _____

APPENDIX C: MEDICAL HISTORY AND DEMOGRAPHIC QUESTIONNAIRE

MEDICAL QUESTIONNAIRE.

<u>DO ANY OF THE FOLLOWING APPLY TO YOU?</u>	YES	NO	DON' KNO'
Do you have a job or lifestyle which mostly involves sitting ? (i.e. Are you physically inactive?)	—	—	—
Are you currently taking or have you ever been on medication for high blood pressure, or has your doctor ever told you that you have high blood pressure?	—	—	—
Do you currently smoke or have you stopped within the past 3 months?	—	—	—
Do you know your serum cholesterol levels? Have you ever been told by your doctor/pharmacist that you have elevated serum cholesterol or blood fat levels?	—	—	—
Has any person in your family had a heart attack or suffered sudden death prior to the age of 55 years (father or brother) or 65 years (mother or sister)?	—	—	—

HAVE YOU EVER BEEN TOLD THAT YOU HAVE HAD OR HAVE ANY OF THE FOLLOWING CONDITIONS?

- | | |
|---|--|
| <input type="checkbox"/> Heart attack | <input type="checkbox"/> Flu |
| <input type="checkbox"/> Coronary thrombosis (blood clot) | <input type="checkbox"/> Bronchitis |
| <input type="checkbox"/> Narrowing of arteries | <input type="checkbox"/> Stroke |
| <input type="checkbox"/> High cholesterol | <input type="checkbox"/> Thyroid problems |
| <input type="checkbox"/> High blood pressure | <input type="checkbox"/> Chronic obstructive disease |
| <input type="checkbox"/> Rheumatic Fever | <input type="checkbox"/> Neurological disorder |
| <input type="checkbox"/> Angina/chest pain | <input type="checkbox"/> Chronic organ conditions (Please specify) |

- | | |
|---|---|
| <input type="checkbox"/> Congenital heart disease | <input type="checkbox"/> Muscle injury (chronic or acute) |
| <input type="checkbox"/> Osteoporosis | <input type="checkbox"/> Back problem |
| <input type="checkbox"/> Asthma | <input type="checkbox"/> currently pregnant or lactating |
| <input type="checkbox"/> Emphysema | <input type="checkbox"/> Diabetes |
| <input type="checkbox"/> Arthritis | <input type="checkbox"/> Epilepsy |
| <input type="checkbox"/> Phlebitis | <input type="checkbox"/> Obesity |
| <input type="checkbox"/> Cancer | <input type="checkbox"/> Other (please specify) _____ |

DO YOU USE ANY MEDICATION AT PRESENT FOR ANY OF THE ABOVE CONDITIONS?

(If yes, please state the drug and the condition for which it was prescribed)

PERSONAL DETAILS

Name.....

Date.....

Please tick where necessary.

Occupation.....

Date of birth.....

[1] Male..... [2] Female.....

What is the highest standard you passed at school?

[1] Less than Std 5....

[2] Std 5.....

[3] Std 6.....

[4] Std 7....

[5] Std 8....

[6] Std 9....

[7] Matric.....

What is your highest qualification:

[8] College.....

[9] Technicon.....

[10] University.....

[11] Other.....

Home Language:[1] English..... [2]Afrikaans..... [3] Xhosa..... [4] Other.....

Postal address.....

.....

.....

Telephone Number: (h)..... (w).....

Age..... yrs

Weight.....kg

Height.....m

Waist circumference.....cm

Skinfolds:

Bicep_____

Tricep_____

Suprailliac_____

Subscapula_____

TRACK TEST RESULTS

Resting HR:	Laps completed	Distance calculated	km/h	Inten- sity	Ave HR
Trial One Monitor.....					
Trial Two					
2km walk test Monitor.....	Time:	Ave HR:	Vo2:	Rating:	

APPENDIX D: TRIAL ONE PHYSICAL ACTIVITY QUESTIONNAIRE

International Physical Activity Questionnaire
Young and Middle-aged Adults
Length-1, Draft 6 RSA
(IPAQ-YMA-L1-L-D6)

SHORT FORMAT

Now I am going to ask you about the time you spend being physically active in a usual week. Please answer each question even if you do not consider yourself to be an active person. I will be asking you about activities you did at work, to get from place to place, for recreation, exercise or sport, or as part of your house or garden chores.

Preamble

When we refer to vigorous or hard activity, this includes activities that cause you to be 'out of breath' or "breathless" or have difficulty in holding a conversation; cause your heart to 'pound'; or cause heavy sweating, even on a cold day. This is equivalent to jogging or running.

When we refer to moderate activity, this includes activities that cause you to be 'a little out of breath' but still able to speak; cause your heart to beat faster; or cause light sweating, even on a cold day. This is equivalent to fast walking.

- 1a During your usual week on how many days did you do activities which take vigorous or hard effort, for at least 10 minutes at a time, like digging, running, soccer, heavy yardwork, fast cycling or swimming, or anything else which caused large increases in breathing or heart rate?¹

_____ days

Refused ²

Don't know ²

(If respondent answers zero, refuses or does not know, skip to Question 2a)

- 1b On the days you did vigorous activity for at least 10 minutes, how much time in total did you spend doing it?

_____ hours _____ minutes

- 2a During your usual week on how many days did you do activities which took moderate effort, for at least 10 minutes at a time, like cycling, vacuuming, gardening or anything else which caused some increase in breathing or heart rate?¹ (Please do not include walking in your answer).

_____ days

Refused ²

Don't know ²

(If respondent answers zero, refuses or does not know, skip to Question 3a)

- 2b On the days you did moderate activity for at least 10 minutes, how much time in total did you spend doing it?

Appendix D: International Physical Activity Questionnaire draft 6

**International Physical Activity Questionnaire
Young and Middle-aged Adults**

Length-2 RSA

Draft 6

(IPAQ-YMA-L2-L-D6)

LONG FORMAT

Now I am going to ask you about the time you spent being physically active during your usual week. Please answer each question even if you do not consider yourself to be an active person. I will be asking you about activities you did at work, to get from place to place, for recreation, exercise or sport, or as part of your house or garden chores.

Preamble

When we refer to vigorous or hard activity, this includes activities that cause you to be 'out of breath' or "breathless" or have difficulty in holding a conversation; cause your heart to 'pound'; or cause heavy sweating, even on a cold day. This is equivalent to jogging or running.

When we refer to moderate activity, this includes activities that cause you to be 'a little out of breath' but still able to speak; cause your heart to beat faster; or cause light sweating, even on a cold day. This is equivalent to fast walking.

Part 1: Occupational physical activity

Now, please think about all the physical activity you do as part of your paid or unpaid work. Please do *not* include travelling to and from work.

1a Do you currently have one or more jobs or do you do unpaid work outside your home?

Yes _____ (go to *Question 1b*)

No _____ (skip to *Question 2a*)

Refused ²

Don't know ²

1.1a What is your job or occupation? _____

1b During your usual week, how many days did you do this kind of work?

_____ days

Refused ²

Don't know ²

1c On an average work day, how much time in total did you spend...
Doing activities which lasted for at least 10 minutes and which took vigorous or hard effort like digging, heavy construction work, carrying parcels up stairs or anything else which caused large increases in breathing or heart rate?

_____ hours _____ minutes

1d Doing activities which lasted for at least 10 minutes and which took moderate effort like carrying light loads or anything else that caused some increase in breathing or heart rate?

_____ hours _____ minutes

Appendix D: International Physical Activity Questionnaire draft 6
_____ hours _____ minutes

3a During your usual week on how many days did you walk at a brisk pace, for at least 10 minutes at a time, to get from place to place, for recreation, pleasure or exercise?

a _____ days

b Refused ²

c Don't know ²

(If respondent answers zero, refuses or does not know, skip to *Question 4a*)

3b On the days on which you walked for at least 10 minutes, how much time in total did you spend walking?

_____ hours _____ minutes or
_____ km

3c During your usual week on how many days did you walk at a slow or easy pace, for at least 10 minutes at a time, to get from place to place, for recreation, pleasure or exercise?

a _____ days

b Refused ²

c Don't know ²

(If respondent answers zero, refuses or does not know, skip to *Question 4a*)

3d On the days on which you walked for at least 10 minutes, how much time in total did you spend walking or how far?

_____ hours _____ minutes or
_____ km

Now, think about all of the time you spent sitting or lying down during a usual week while at home, at work, while getting from place to place or during your spare time.

4a On an average *week day*, how many hours in total did you spend sitting or lying down while doing things like visiting friends, reading, watching television or working at a desk or computer?

_____ hours _____ minutes

4b On an average *weekend day*, how many hours in total did you spend sitting or lying down while visiting friends, reading, watching television or working at a desk or computer?

_____ hours _____ minutes

¹ These examples can be replaced with culture-specific examples

² These responses will not be read to the respondent, but are included for the purpose of data coding

Appendix D: International Physical Activity Questionnaire draft 6

1e Walking at a brisk pace for at least 10 minutes _____ hours ____ minutes

1f Sitting _____ hours ____ minutes

Part 2: Household and garden/yardwork physical activity

Now, please think about all the activities that you did *at home or in the garden/yard* during your usual week . Please do not include exercise you did at home to improve your fitness or health.

2a During your usual week, on how many days did you do activities *in the garden or yard*, for at least 10 minutes at a time, which took vigorous or hard effort like chopping wood, digging, or anything else which caused large increases in breathing or heart rate?

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 2c*)

2b On the days you did these vigorous activities for at least 10 minutes, how much time in total did you spend doing them?

_____ hours ____ minutes

2c During your usual week, on how many days did you do activities *in the garden or yard*, for at least 10 minutes at a time, which took moderate effort like sweeping, raking or anything else which caused some increase in breathing or heart rate?

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 2e*)

2d On the days you did these moderate activities for at least 10 minutes, how much time in total did you spend doing them?

_____ hours ____ minutes

2e During your usual week, on how many days did you do activities *inside* your home, for at least 10 minutes at a time, which took moderate effort like vacuuming, scrubbing floors, washing windows or anything else which caused some increase in breathing or heart rate?

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 2c*)

Appendix D: International Physical Activity Questionnaire draft 6

- 2f On the days you did these moderate activities for at least 10 minutes, how much time in total did you spend doing them?

_____ hours _____ minutes

Part 3: Transportation physical activity

Now, please think about how you *got from place to place* during the last 7 days.

- 3a During your usual week, on how many days did you walk briskly, for at least 10 minutes at a time, to get from place to place? (Do not include walking for recreation, pleasure or exercise or as part of your work).

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 3c*)

- 3.1a During your usual week on how many days did you walk at a slow or easy pace, for at least 10 minutes at a time, to get from place to place.

a _____ days

b Refused ²

c Don't know ²

(If respondent answers zero, refuses or does not know, skip to *Question 4a*)

- 3.1b On the days on which you walked for at least 10 minutes, how much time in total did you spend walking or how far?

_____ hours _____ minutes or
_____ km

- 3b During your usual week, on the days you walked briskly for at least 10 minutes to get from place to place, how much time in total did you spend doing this type of walking?

_____ hours _____ minutes

- 3c During your usual week, on how many days did you cycle briskly, for at least 10 minutes at a time, to get from place to place? (Do not include cycling for recreation, pleasure or exercise).

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 3e*)

- 3d During your usual week, on the days you cycled for at least 10 minutes to get from place to place, how much time in total did you spend cycling? (Do not include cycling for recreation, pleasure or exercise).

Appendix D: International Physical Activity Questionnaire draft 6

____ hours ____ minutes

- 3e During your usual week, on how many days did you ride in a motor vehicle (like a train, bus, combi, car or taxi) to get from place to place?

____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 4a*)

- 3f On the days you rode in a motor vehicle, much time in total did you spend riding in one?

____ hours ____ minutes

Part 4: Recreation, Sport, and Leisure-time physical activity

Now, please think about all the activities that you did *in your leisure time* for recreation, sport or exercise during your usual week. Please do not include any activities you have already mentioned.

- 4a During your usual week, on how many days did you do activities *in your leisure-time*, which lasted for at least 10 minutes at a time, and which took vigorous or hard effort like running, aerobics, fast swimming, playing hard sports like soccer or anything else which caused large increases in breathing or heart rate?

____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 4c*)

- 4b On the days you did these vigorous activities for at least 10 minutes, how much time in total did you spend doing them?

____ hours ____ minutes

- 4c During your usual week, on how many days did you do activities *in your leisure-time*, which lasted for at least 10 minutes at a time, and which took moderate effort like easy cycling or swimming, doubles tennis or anything else which caused some increase in breathing or heart rate? (Do not include walking).

____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 4e*)

- 4d On the days you did these moderate activities for at least 10 minutes, how much time in total did you spend doing them?

____ hours ____ minutes

Appendix D: International Physical Activity Questionnaire draft 6

- 4e During your usual week, on how many days did you walk briskly, for at least 10 minutes at a time, for pleasure or exercise? (Do not include any walking at work or for transportation which you have already told me about).

_____ days

Refused

Don't know

(If respondent answers zero, refuses or does not know, skip to *Question 4g*)

- 4f On the days you walked at least 10 minutes at a time for pleasure or exercise, how much time in total did you spend walking?

_____ hours _____ minutes

- 4g On an average *week day*, how much time did you spend sitting or lying down while doing things like reading, watching television or working at a desk or computer?

_____ hours _____ minutes

- 4h On an average *weekend day*, how much time did you spend sitting or lying down while doing things like reading, watching television or working at a desk or computer?

_____ hours _____ minutes

¹ These examples can be replaced with culture-specific examples

² These responses will not be read to the respondent, but are included for the purpose of data coding

SIX MINUTE TEST: LAP RECORDING SHEET

Moderate pace

Vigorous pace ↓

[illegible]

APPENDIX F: SUBJECT REPORTBACK

**Bioenergetics of Exercise Research Unit of the Medical
Research Council and the University of Cape Town**

**Sport Science Institute of South Africa
Boundry Road
Newlands
7500
Tel: 021 686 7330
Fax: 021 686 7530
25 May 1999**

Dear

Thank you for taking part in my research study entitled "*The Standardisation of Physical Activity Assessment and Measurement of Physical Activity Prevalence in South African Communities*".

The purpose of this phase of the study was to validate an international physical activity questionnaire for the World Health Organisation (WHO).

Your time and effort was greatly appreciated and has helped further the development of research in a vital part of public health. The results which may interest you appear below.

Your body fat % -.....

Recommended range: 9-22% for males 19-30% for females

Your predicted Vo2 Max, which is an indication of your cardio vascular fitness and your body's

ability to utilise oxygen was ml.min.kg Therefore your rating is:.....

If you would like any further details on your results or the outcome of the study please feel free to contact me.

Thank you again.

Yours truly,

Isabelle M.T. Bohlmann

APPENDIX G: PROTOCOL OF TRAIL ONE- Chapter 3

- 1. Arrive**
- 2. Fill in personal details, informed consent, medical questionnaire**
- 3. Measure anthropometry: Height, weight, skinfolds.**
- 4. Put on HR monitors, explain protocol**
- 5. Walk 6 min at a moderate pace**
- 6. Measure distance**
- 7. Give 10-15 minute rest**
- 8. Walk 6 minutes vigorous pace**
- 9. Remove HR monitors**
- 10. Fill in long and short physical activity questionnaire (SA modified IPAQ)**
- 11. Download HR**
- 12. Analyse data, BMI. Ensure: equal distribution of age, sex, language and level of urbanisation**
- 13. Results returned to subjects: Fat %, fitness test.**

APPENDIX H: RESULTS OF PILOT STUDY- TRIAL ONE

Descriptive Statistics: N=26

Females

Variable	Mean	Std Deviation
Age	36yrs	12.4yrs
Weight	71kg	11.4kg
Height	1.62m	0.9m
SSF	71.2mm	32.6mm
% Fat	30.9%	6.1%
Moderate pace	5.7km/h	0.7km/h
Moderate pace HR	115bpm	11bpm
Vigorous pace	6.6km/h	0.9km/h
Vigorous pace HR	135bpm	16bpm
VO₂max	37ml.kg.min	9ml.kg.min

Males

Variable	Mean	Std Deviation
Age	36yrs	7yrs
Weight	76.5kg	16kg
Height	1.72m	0.8m
SSF	35mm	14mm
% Fat	18%	6.8%
Moderate pace	5.9km/h	0.7km/h
Moderate pace HR	96bpm	11bpm
Vigorous pace	7.3km/h	0.3km/h
Vigorous pace HR	118bpm	22bpm
VO₂max	48ml.kg.min	12ml.kg.min

APPENDIX I.

**INTERNATIONAL PHYSICAL ACTIVITY
QUESTIONNAIRE (IPAQ) FORMS USED FROM THE
MANUAL OF OPERATIONS (IPAQ WORKING GROUP)
TO STANDARDIZE TESTING IN ALL CENTRES.**

LABEL HERE

IPAQ Reliability and Validity Study

DEMOGRAPHIC SURVEY-FORM 9

The next few questions are about where who you are and where you live. Please make a check in the space that represents your answer.

1. What is your sex?

- ☐ Male (1)
☐ Female (2)




2. How old were you on your last birthday?

- ☐ Years
☐ Don't know/Not sure (77)
☐ Refuse to answer (99)

3. How many years of education have you completed?

- ☐ Years
☐ Don't Know/Not Sure (7)
☐ Refuse to Answer (9)

4. Do you currently work for pay?

- ☐ Yes (1)
☐ No (2)  *Go to Item 6*
☐ Don't Know/Not Sure (77)  *Go to Item 6*
☐ Refuse to Answer (99)  *Go to Item 6*

5. If yes, how many hours per week do you work in all jobs?

- ☐ Hours/week
☐ Don't know/Not sure (777)
☐ Refuse to Answer (999)

6. Which location best describes where you live?

- ☐ Large city (> 100,000 people) (1)
☐ Smaller city (30,000 – 100,000 people) (2)
☐ Rural city (1,000 – 29,999 people) (3)
☐ Small community/village (< 1,000 people) (4)
☐ Don't know/Not sure (7)
☐ Refuse to Answer (9)

7. Now, I would like to ask you about your health. Would you say that in general your health is

- ☐ Excellent (1)
☐ Very good (2)
☐ Good (3)
☐ Fair (4)
☐ Poor (5)
☐ Don't know/Not sure (7)
☐ Refuse to Answer (9)

ID - - -

Country # Site Subject #

IPAQ Reliability and Validity Study

Subject Tracking Form

Form 13

Date _____

Name _____

Last
First

MI

Address _____

City

Street

State/
Province

Country

Home Phone _____

Work Phone _____

Visit Schedule:

(Circle Type of Study)

Reliability

Validity

Reliability/Validity

Visit #	Date	Time	Tasks Completed	CSA #	Digi #	Comments
1						
2						
3						

Notes

LABEL HERE

IPAQ
DEMOGRAPHIC SURVEY RSA-FORM 9A

1. Place of birth:

--	--	--	--	--

2. Were you born in a

a. a rural village.....

b. a farm.....

c. a small town.....

d. a large town/ city....

--

3. Where did you spend most of your childhood?
(up to 10 years)

a. a rural village.....

b. a farm.....

c. a small town.....

d. a large town/ city....

--

4. Which of the following best describes where
you are you currently living:

a. a rural village.....

b. a farm.....

c. a small town.....

d. a large town/ city..

--

5. How many years have you been living where
you are currently living?

--	--

 years

--	--

6. How many people (including children) live in your
house/dwelling?.....

--	--

 persons

--	--

7. How many rooms are used for sleeping in your house?.....

--	--

8. What type of dwelling do you live in? (tick one)

a. Built formal housing unit....

b. Informal shack-shelter.....

c. Hostel.....

d. Tent.....

e. Other.....

--

9. Is this dwelling...

a. rented.....

b. purchased.....

c. squatting (no rent).....

--

10. Does any one or more persons in your household
own a motor car or other passenger vehicle?

	yes		no
--	-----	--	----

--

11. Do you have electricity available inside your household?..... ☐ yes ☐ no ☐

11

12. How is your water supplied?

- a. Tap in house..... ☐
- b. Tap outside house..... ☐
- d. Shared tap (4 houses)..... ☐
- e. Communal tap ☐
- (5 or more houses)

12

13. Do you have a fridge or deep freeze in your house?..... ☐ yes ☐ no ☐

13

14. Have you watched television this week?..... ☐ yes ☐ no ☐

14

15. Have you read a newspaper this week?..... ☐ yes ☐ no ☐

15

16. Do you listen to a radio in your household?..... ☐ yes ☐ no ☐

16

17. What is the highest standard you passed at school?.....

- a. did not complete Std 6..... ☐
- b. Std 6..... ☐
- c. Std 7..... ☐
- d. Std 8..... ☐
- e. Std 9..... ☐
- f. Matric..... ☐
- g. Post-matric technikon..... ☐
- h. Post-matric university..... ☐

17

18. What is your home language

- a. Afrikaans..... ☐
- b. English..... ☐
- c. Sotho..... ☐
- d. Swana..... ☐
- e. Xhosa..... ☐
- f. Zulu..... ☐
- g. Other..... ☐

18

19. What is your occupation.....

19

LABEL HERE

IPAQ Reliability and Validity Study
Height, Weight, and Sum of Skinfolts

Form 15

Height (Circle Unit) **Centimeters** **Inches** **Meters**

Trial 1 _____. ____

Trial 2 _____. ____

Average Height in CM _____. ____

Weight (Circle Unit) **Kilograms** **Pounds** **Stones** **Type or Brand of Scale**

Trial 1 _____. ____

Trial 2 _____. ____

Average Weight in KG _____. ____

Sum of 3 Skinfolts

Male **Trial 1** Chest ____ mm Abdomen ____ mm Thigh ____ mm

Trial 2 Chest ____ mm Abdomen ____ mm Thigh ____ mm

Average	Chest ____ mm	Abdomen ____ mm	Thigh ____ mm
----------------	---------------	-----------------	---------------

Female **Trial 1** Triceps ____ mm Suprailium ____ mm Thigh ____ mm

Trial 2 Triceps ____ mm Suprailium ____ mm Thigh ____ mm

Average	Triceps ____ mm	Suprailium ____ mm	Thigh ____ mm
----------------	-----------------	--------------------	---------------

South African Additional Skinfolds – (OPTIONAL)

Male Trial 1 Suprailium ___ mm Biceps ___ mm Triceps ___ mm Subscap ___ mm

Trial 2 Suprailium ___ mm Biceps ___ mm Triceps ___ mm Subscap ___ mm

Avg	Suprailium ___ mm	Biceps ___ mm	Triceps ___ mm	Subscap ___ mm
------------	-------------------	---------------	----------------	----------------

Female Trial 1 Biceps ___ mm Subscap ___ mm Abdomen ___ mm

Trial 2 Biceps ___ mm Subscap ___ mm Abdomen ___ mm

Average	Biceps ___ mm	Subscap ___ mm	Abdomen ___ mm
----------------	---------------	----------------	----------------

Label Here

IPAQ Medical History Form 19

DO ANY OF THE FOLLOWING APPLY TO YOU?

**YES NO DON'T
KNOW**

Do you have a job or lifestyle which mostly involves sitting ?
(ie. Are you physically inactive)?

— — —

Are you currently taking or have you ever been on
medication for high blood pressure, or has your doctor
ever told you that you have high blood pressure?

— — —

Do you currently smoke or have you stopped within the past 3 months?

— — —

Do you know your serum cholesterol levels? Have you ever
been told by your doctor/pharmacist that you have elevated
serum cholesterol or blood fat levels?

— — —

Has any person in your family had a heart attack or suffered
sudden death prior to the age of 55 years (father or brother)
or 65 years (mother or sister)?

— — —

***HAVE YOU EVER BEEN TOLD THAT YOU HAVE HAD OR HAVE ANY OF THE FOLLOWING
CONDITIONS?***

☐ Heart attack

☐ Flu

☐ Coronary thrombosis (blood clot)

☐ Bronchitis

☐ Narrowing of arteries

☐ Stroke

☐ High cholesterol

☐ Thyroid problems

☐ High blood pressure

☐ Chronic obstructive disease

☐ Rheumatic Fever

☐ Neurological disorder

☐ Angina/chest pain

☐ Chronic organ conditions (Please specify) _____

☐ Congenital heart disease

☐ Muscle injury (chronic or acute)

☐ Osteoporosis

☐ Back problem

☐ Asthma

☐ currently pregnant or lactating

☐ Emphysema

☐ Diabetes

☐ Arthritis

☐ Epilepsy

☐ Phlebitis

☐ Obesity

☐ Cancer

☐ Other (please specify) _____

DO YOU USE ANY MEDICATION AT PRESENT FOR ANY OF THE ABOVE CONDITIONS?
(If yes, please state the drug and the condition for which it was prescribed)

LABEL HERE

IPAQ Step Test Data Form 20

Name: _____

Age: _____ **yrs** **Gender:** _____ **male** _____ **female (tick)**

Heart rate for 1 min recovery: _____ **bpm**

Comments:

LABEL HERE

IPAQ Reliability and Validity Study

FORM 7

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE YOUNG AND MIDDLE-AGED ADULTS SHORT USUAL WEEK VERSION 8

VERSION FOR RELIABILITY AND VALIDITY TESTING TELEPHONE FORMAT

[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY
CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS VALUES.
(SEE AINSWORTH ET AL)]

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. This is part of a large study being conducted in many countries around the world. Your answers will help us to understand how active we are compared with people in other countries.

I am going to ask you about the time you spend being physically active in a usual week. Please answer each question even if you do not consider yourself to be an active person. I will be asking you about activities you do at work, to get from place to place, as part of your house and yard work, and in your spare time for recreation, exercise or sport.

- 1a Now, think about all the vigorous activities which take **hard physical effort** that you might do *during a usual week*. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think about *only* those physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do vigorous physical activities?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer: Include all jobs.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to
Question 2a]

- 1b How much time in total would you usually spend on one of those days doing **vigorous** physical activities?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "How much time in total would you spend in a **usual week** doing vigorous physical activities?"

_____ hours _____ minutes per week]

- 2a Now think about activities which take **moderate physical effort** that you might do *during a usual week*? .Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about *only* those physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do **moderate physical activities**?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer: Include all jobs.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to *Question 3a*]

- 2b How much time in total would you usually spend on one of those days doing **moderate physical activities**?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: How much time in total would you spend in a **usual week** doing moderate physical activities *during a usual week*?

_____ hours _____ minutes per week]

- 3a Now think about the time you spend walking *during a usual week*. This includes walking at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise or leisure.

On how many days in a usual week do you walk for at least 10 minutes at a time?

[Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]

[Interviewer: Include all jobs.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to *Question 4a*]

- 3b How much time in total would you usually spend walking on one of those days?

_____ hours _____ minutes

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend walking in a **usual week**?

_____ hours _____ minutes per week]

- 3c At what pace do you **usually** walk? Do you walk at:
___ a **Vigorous** pace, that makes you breathe much harder than normal;
___ a **Moderate** pace that makes you breathe somewhat harder than normal; or
___ a **Slower** pace where there is no change in your breathing.
[Interviewer probe: A usual pace is being sought. If the respondent can't answer because the pace varies widely from day to day, or from across job, transportation and leisure categories, ask: How much time would you spend in a **usual week** walking at a **slow** pace?
___ hours ___ minutes per week]

The last questions are about the time you spend sitting each day while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

- 4a How much time in total did you usually spend *sitting* on a **week day**?
___ hours ___ minutes
[Interviewer clarification: Include time spent lying down (awake) as well as sitting]
[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time **in total** would you spend *sitting* in a **usual week**?
___ hours ___ minutes per week [skip to end]
- 4b How much time in total did you usually spend *sitting* on a **weekend day**?
___ hours ___ minutes

LABEL HERE

IPAQ Reliability and Validity Study

FORM 3

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE YOUNG AND MIDDLE-AGED ADULTS LONG USUAL WEEK VERSION 8

VERSION FOR RELIABILITY AND VALIDITY TESTING TELEPHONE FORMAT

[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY
CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS VALUES.
(SEE AINSWORTH ET AL)]

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. This is part of a large study being conducted in many countries around the world. Your answers will help us to understand how active we are compared with people in other countries.

I am going to ask you about the time you spend being physically active in a usual week. Please answer each question even if you do not consider yourself to be an active person. I will be asking you about activities you do at work, to get from place to place, as part of your house and yard work, and in your spare time for recreation, exercise or sport.

Job-Related Physical Activity

The first questions are about your work. This includes paid jobs, farming, volunteer work, course work and other unpaid work that you do outside your home. Do not include unpaid work you might do *around your home*, like housework, yard work, general maintenance, or caring for your family. I will ask you about these later.

- 1a Do you currently have a job or do any unpaid work outside your home?
[Interviewer clarification: This also includes credit and non-credit classes or course work. It also includes volunteer work and time spent looking for work. It does not include unpaid house or yard work, nor caring for dependents. This will be asked in a later section]

Yes _____ (go to Question 1b)

No _____ (skip to Question 2a)

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

The following questions are about all the physical activity you do in a usual week as part of your paid or unpaid work. This does *not* include travelling to and from work.

- 1b First, think about all the vigorous activities which take hard physical effort that you might do *as part of your work*. Vigorous activities make you breathe much harder than normal and may include things like heavy lifting, digging, heavy construction work, or climbing up stairs. Think about *only* those vigorous physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do vigorous physical activities *as part of your work*?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer: Work includes paid and unpaid work as well as course work. Include all jobs and volunteer work.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 1d]

- 1c How much time in total would you usually spend on one of those days doing vigorous physical activities *as part of your work*?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of paid and unpaid work, ask: "How much time in total would you spend in a usual week doing vigorous physical activities *as part of your work*?"

_____ hours _____ minutes per week]

- 1d Now think about activities which take moderate physical effort that you might do *as part of your work*. Moderate physical activities make you breathe somewhat harder than normal and may include activities like carrying light loads. Do not include walking. Again, think about *only* those moderate physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do moderate physical activities *as part of your work*?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer: Work includes paid and unpaid work as well as course work. Include all jobs.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 1f]

- 1e How much time in total would you usually spend on one of those days doing moderate physical activities *as part of your work*?
 ____ hours ____ minutes
 [Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]
 [Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of paid and unpaid work, ask: How much time in total would you spend in a usual week doing moderate physical activities *as part of your work*?
 ____ hours ____ minutes per week]
- 1f Now think about the time you spend walking for at least 10 minutes at a time *as part of your work*. Please do not count any walking you do to travel to or from work.
- On how many days in a usual week do you walk *as part of your work*?
 [Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]
 [Interviewer: Include all jobs.]
 ____ days per week
 Refused [Interviewer: Do not read]
 Don't know [Interviewer: Do not read]
 [Interviewer: If respondent answers zero, refuses or does not know, skip to Question 2a]
- 1g How much time in total would you usually spend on one of those days walking *as part of your work*?
 ____ hours ____ minutes
 [Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]
 [Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: How much time in total would you spend in a usual week walking *as part of your paid work*?
 ____ hours ____ minutes per week]
- 1h When walking *as part of your work*, at what pace do you usually walk? Do you walk at:
 ____ a Vigorous pace;
 ____ a Moderate pace or
 ____ a Slower pace.
 [Interviewer clarification: Do you walk at
 ____ a Vigorous pace, that makes you breathe much harder than normal;
 ____ a Moderate pace that makes you breathe somewhat harder than normal;
 or
 ____ a Slower pace where there is no change in your breathing]
 [Interviewer probe: A usual pace is being sought. If the respondent can't answer because the pace varies widely from day to day, or from job to job, ask: How much time would you spend in a usual week walking at a slow pace *as part of your paid work*? ____ hours ____ minutes per week]

Part 2: Transportation Physical Activity

- 2a Now, I am going to ask you about how you typically travel to go from place to place in a usual week, including to places like work, stores, movies and so on.

On how many days in a usual week do you travel in a motor vehicle like a train, bus, car or tram?

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 2c]

- 2b How much time in total did you usually spend on one of those days *travelling in a car, bus, train or other kind of motor vehicle?*

_____ hours _____ minutes

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: Can you tell me the total amount of time you spend in a usual week *travelling in a motor vehicle?*

_____ hours _____ minutes per week

- 2c Now think only about the *bicycling* you might do to travel to and from work, to do errands, or to go from place to place. *Only* include bicycling that you do for at least 10 minutes at a time.

On how many days in a usual week do you bicycle *to go from place to place?*

[Interviewer clarification: Think about only the bicycling that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 2f]

- 2d How much time in total would you usually spend on one of those days *to bicycle from place to place?*

_____ hours _____ minutes

[Interviewer clarification: Think about only the bicycling that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend bicycling in a usual week *to travel from place to place?*

_____ hours _____ minutes per week

- 2e When *traveling by bicycle*, at what pace do you usually bike? Do you bike at:
 ___ a **Vigorous** pace, that makes you breathe much harder than normal;
 ___ a **Moderate** pace that makes you breathe somewhat harder than normal; or
 ___ a **Slower** pace where there is no change in your breathing.
- 2f Now think **only** about the *walking* you might do *to travel* to and from work, to do errands or to go from place to place. *Only* include walking that you do for at least 10 minutes at a time
- On how many days in a usual week do you walk *to go from place to place*?
 [Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]
 _____ days per week
 Refused [Interviewer: Do not read]
 Don't know [Interviewer: Do not read]
 [Interviewer: If respondent answers zero, refuses or does not know, skip to Question 3a]
- 2g How much time in total would you usually spend on one of those days walking *from place to place*?
 ___ hours ___ minutes
 [Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]
 [Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend in a usual week *walking to commute*?]
 ___ hours ___ minutes per week
- 2h When walking from place to place, at what pace do you usually walk? Do you walk at:
 ___ a **Vigorous** pace;
 ___ a **Moderate** pace or
 ___ a **Slower** pace.
 [Interviewer clarification: Do you walk at
 ___ a **Vigorous** pace, that makes you breathe much harder than normal;
 ___ a **Moderate** pace that makes you breathe somewhat harder than normal;
 or
 ___ a **Slower** pace where there is no change in your breathing]

Part 3. Housework, House Maintenance, and Caring for Family

- 3a Now I will ask you about some of the physical activities you might do in a usual week *in and around your home*, for example, your housework, gardening, yard work, general maintenance work, or caring for your family.

First, think about **vigorous** activities which take **hard physical effort** that you do *in the garden or yard*. Vigorous activities make you breathe much harder than normal and may include heavy lifting, chopping wood, shoveling snow, or digging. Again, think about *only* those vigorous physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do **vigorous** physical activities *in the garden or yard*

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 3c]

- 3b How much time in total would you usually spend on one of those days doing **vigorous** physical activities *in the garden or yard*?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: What is the total amount of time you would spend in a usual week doing vigorous physical activities *in the garden or yard*?

_____ hours _____ minutes per week

- 3c Now think about activities which take **moderate physical effort** that you do *in the garden or yard*. Moderate activities make you breathe somewhat harder than normal and may include carrying light loads, sweeping, washing windows, and raking. Again, include *only* those moderate physical activities that you do for at least 10 minutes at a time.

On how many days in a usual week do you do **moderate** activities *in the garden or yard*?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 3e]

- 3d How much time in total would you usually spend on one of those days doing **moderate physical activities in the garden or yard**?
 ____ hours ____ minutes
 [Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]
 [Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:
 What is the total amount of time you would spend in a **usual week** doing moderate physical activities *in the garden or yard*?
 ____ hours ____ minutes per week]
- 3e Now think about activities which take at least **moderate physical effort** that you do *inside your home*. Examples include carrying light loads, washing windows, scrubbing floors and sweeping. Include *only* those moderate physical activities that you do for at least 10 minutes at a time.
 [Interviewer clarification: Moderate activities make you breathe somewhat harder than normal]
- On how many days in a usual week do you do **moderate activities inside your home**?
 [Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]
 [Interviewer clarification: On how many days in a usual week do you do activities that take at least **moderate effort inside your home**
- ____ days per week
 Refused [Interviewer: Do not read]
 Don't know [Interviewer: Do not read]
 [Interviewer: If respondent answers zero, refuses or does not know, skip to Question 4a]
- 3f How much time in total would you usually spend on one of those days doing **moderate physical activities inside your home**?
 ____ hours ____ minutes
 [Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]
 [Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:
 What is the total amount of time you would spend in a **usual week** doing moderate physical activities *inside your home*?
 ____ hours ____ minutes per week]

Part 4: Recreation, Sport, and Leisure-Time Physical Activity

- 4a Now, I am going to ask you about all the physical activities that you do in a usual week solely for recreation, sport, exercise or leisure. Please do NOT include any activities you have already mentioned.

Not counting any walking you have already mentioned, on how many days in a usual week do you walk for at least 10 minutes at a time *in your leisure time*?

[Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 4d]

- 4b How much time in total would you usually spend on one of those days *walking in your leisure time*?

_____ hours _____ minutes

[Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend in a usual week *walking in your leisure time*?

_____ hours _____ minutes per week

- 4c When walking in your leisure time, at what pace do you usually walk? Do you walk at:
_____ a Vigorous pace;
_____ a Moderate pace or
_____ a Slower pace.

[Interviewer clarification: Do you walk at

_____ a Vigorous pace, that makes you breathe much harder than normal;

_____ a Moderate pace that makes you breathe somewhat harder than normal;

or

_____ a Slower pace where there is no change in your breathing]

- 4d Now think about other physical activities you do in your leisure time for at least 10 minutes at a time.

First, think about vigorous activities which take hard physical effort that you do in your leisure time. Examples include aerobics, running, fast bicycling, or fast swimming.

[Interviewer clarification: Vigorous activities make you breathe much harder than normal]

On how many days in a usual week do you do vigorous physical activities in your leisure time?

[Interviewer clarification: Think about only those vigorous physical activities that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 4f]

- 4e How much time in total would you usually spend on one of those days doing vigorous physical activities in your leisure time?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend in a usual week doing vigorous physical activities in your leisure time?

_____ hours _____ minutes per week

- 4f Now think about activities which take moderate physical effort that you do in your leisure time. Examples include bicycling at a regular pace, swimming at a regular pace, and doubles tennis. Again, include only those moderate activities that you do for at least 10 minutes at a time.

[Interviewer clarification: Moderate activities make you breathe somewhat harder than normal]

On how many days in a usual week do you do moderate physical activities in your leisure time?

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

_____ days per week

Refused [Interviewer: Do not read]

Don't know [Interviewer: Do not read]

[Interviewer: If respondent answers zero, refuses or does not know, skip to Question 5a]

- 4g How much time in total would you usually spend on one of those days doing moderate physical activities *in your leisure time*?

___ hours ___ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend in a usual week *doing moderate physical activities in your leisure time*?

___ hours ___ minutes per week

Part 5: Time Spent Sitting

- 5a The last questions are about the time you spend sitting each day while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

How much time in total did you usually spend *sitting* on a week day?

___ hours ___ minutes

[Interviewer clarification: Include time spent lying down (awake) as well as sitting]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: How much time in total would you spend *sitting* in a usual week?

___ hours ___ minutes per week [skip to end]

- 5b How much time in total did you usually spend *sitting* on a weekend day?

___ hours ___ minutes

APPENDIX J.

ABSTRACT OF PRESENTATION AND REPORT BACK TO THE *INTERNATIONAL
WORKING GROUP FOR THE STANDARDISATION OF THE MEASUREMENT OF
PHYSICAL ACTIVITY FOR PUBLIC HEALTH PURPOSES.*

PRESENTED AT THE AMERICAN COLLEGE OF SPORTS MEDICINE (ACSM)
ANNUAL CONFERENCE, HELD IN INDIANAPOLIS, JUNE 2000.

PRESENTED BY DR E.V. LAMBERT.

APPENDIX J

Challenges in measurement of physical activity for public health purposes in South Africa

E.V. Lambert¹, I. Bohlmann¹, S. MacKinnon², S. Kruger³, I. Cook⁴, L. Leach⁵, J. van Heerden⁶, T. Kolbe¹, B. Peya¹, University of Cape Town¹, Rhodes University², Potchefstroom University³, University of the North⁴, University of the Western Cape⁵, Pretoria University⁶, Physical Activity Working Group of South Africa

There is now a well-recognised relationship between physical activity (PA) and chronic disease that has been described across a variety of cultures and contexts. However, there is little cross-cultural comparison between levels of PA and chronic disease, particularly in developing countries. The International Physical Activity Questionnaire was developed as a means of measuring the global burden of inactivity, and to enable international comparisons in levels of PA. **Subjects and Methods:** In South Africa, we tested the International Physical Activity Questionnaire in 4 convenience sub-samples of South Africans, representing 5 language groups, broad socio-economic diversity and ranging from a rural to an urban setting. Both the long and the short version were interviewer-administered on each occasion, although the order of administration was initially randomised. Test-retest reliability, separated by 3-4 days, was tested on 2 occasions in a group of 149 persons, and a small group of urban and rural persons (N=30). In a smaller, urban sample (N=92), test-re-test reliability was measured on 3 occasions. Criterion validity was measured in a sample of 96 individuals representing 4 language groups, as described below. In a small group of older adults (N=24) from disadvantaged backgrounds, only the short version was administered. Concurrent validity was compared between the long and the short version. Criterion validity was measured using the CSA uni-axial accelerometer, correlating total activity counts, counts per registered time, as well as time spent in vigorous and moderate activity, based on the number of counts per minute (Freedson et al., 1998). **Results:** Test-retest reliability in the first sub-sample was moderate for the short form of the questionnaire in this multicultural sample (Vigorous activity, $R^2 = 0.27$, Moderate, $R^2 = 0.24$, Sitting time, $R^2 = 0.23$). For the longer version, total PA had moderate reliability ($R^2 = 0.24$), however, leisure time PA had a poor test-retest reliability. Concurrent validity between the long and the short forms in this group was highest for total moderate activity ($R^2 = 0.49$, and $R^2 = 0.22$ for visits 1 and 2, respectively) and for sitting time ($R^2 = 0.56$, and $R^2 = 0.63$ for visits 1 and 2 respectively). In the smaller, urban subsample (N=92), overall test-re-test reliability was better, particularly between visits 2 and 3 (R^2 for job, household, leisure, total PA and sitting time were 0.41, 0.73, 0.43, 0.20, 0.60, respectively). Criterion validity was only moderate-to-poor for total PA using the short form ($R^2 = 0.22$) and long form ($R^2 = 0.14$), and was poorly associated with reported vigorous PA. Further analysis suggests that socioeconomic status may be an important confounder when assessing levels of habitual PA in a cross-cultural, urban setting in developing countries. Furthermore, gender, education and home language affect reliability of repeat measures of PA, particularly from the first to the second exposure. We recommend multiple baseline administrations of the IPAQ to minimise any learning effects; to change the order of the questions so that moderate PA precedes vigorous PA to prevent double counting; and to include within the interviewer instructions certain time cues to assist in the weekly recall of activity. The IPAQ provided a moderate measure of total PA levels in a broad cross-cultural sub-sample of South Africans. However, leisure time PA, and vigorous PA had generally poor reliability and criterion validity.

APPENDIX K: IPAQ AFRIKAANS TRANSLATION

**INTERNASIONALE FISIEKE AKTIWITEITS VRAELYS
JONG- EN MIDDELJARIGE VOLWASSENES
GEWONE WEEK FORMAAT
KORT (SHORT)**

**WEERGAWE VIR BETROUBAARHEID- EN GELDIGHEIDSTOETSING
TELEFOON FORMAAT**

**[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY
CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS
VALUES.**

(SEE AINSWORTH ET AL)

Ons stel belang in die verskillende tipes fisieke aktiwiteit wat mense in hulle alledaagse lewe doen. Hierdie is deel van 'n veel groter studie wat wêreldwyd verig word. U antwoorde sal ons help om te verstaan hoe aktief ons is in vergelyking met mense van ander lande.

Ek gaan u nou 'n paar vrae vra oor die hoeveelheid tyd wat u weekliks aktief verkeer. Antwoord asseblief elke vraag, al dink u nie self u is aktief nie. Ek gaan vrae vra met betrekking tot die aktiwiteite wat u by die werk doen, om van plek na plek te kom, wat u as deel van u huis- en tuinwerk doen, en in u vrye tyd vir rekreasie, sport en oefening.

(1a) Dink nou aan al die stremmende aktiwiteite wat u in 'n gewone week sou doen, wat harde fisieke inspanning vereis. Sulke aktiwiteite sal u harder as gewoonlik laat asemhaal. Voorbeelde van die soort aktiwiteite sluit in: swaar voorwerpe oplig, grawe, groot pakkies dra, trappe klim, vinnige fietsry, hardloop aktiwiteite soos sokker, swem en aerobiese dans. Dink nou net aan die fisieke aktiwiteite wat u vir ten minste 10 minute op 'n slag doen.

Hoeveel dae in 'n gewone week beoefen u sulke stremmende fiskieke aktiwiteite?
_____ dae per week

Weier

Weet nie

(1b) Hoeveel tyd in totaal spandeer u aan stremmende fisieke aktiwiteit op een van daardie dae?

_____ ure _____ minute

(2a) Die volgende vraag verwys na die hoeveelheid tyd wat u in 'n gewone week spandeer aan aktiwiteite wat matige inspanning vereis. Die soort aktiwiteite behoort jou effens harder as gewoonlik te laat asemhaal. Voorbeelde is trappe klim, fietsry of swem teen 'n redelike spoed, tennis dubbels of ligte vragte dra. Dink nou net aan sulke aktiwiteite wat u vir ten minste vir 10 minute op 'n slag doen.

Op hoeveel dae in 'n gewone week beoefen u sulke matige fiskieke aktiwiteite?
_____ dae per week

Weier

Weet nie

(2b) Hoeveel tyd in totaal spandeer u aan matige fisieke aktiwiteit op een van daardie dae?

_____ ure _____ minute

(3a) Dink nou aan die tyd wat u in 'n gewone week stap. Dit sluit in by die werk en by die huis, om van plek na plek te stap, en enige ander stap aktiwiteite wat u sou doen in die vorm van rekreasie, sport, oefen of ontspanning.

Op hoeveel dae in 'n gewone week stap u vir ten minste 10 minute?

_____ dae per week

weier

Weet nie

(3b) Hoeveel tyd in totaal stap u op een van daardie dae?

_____ ure _____ minute

(3c) Stap u gewoonlik teen:

_____ 'n Vinnige pas wat u baie harder as gewoonlike laat asemhaal;

_____ 'n Gemiddelde pas wat u effens harder as normaal laat asemhaal;

_____ 'n Stadige pas wat geen verandering in u asemhaling noodsaak nie

Die laaste vrae het betrekking tot die totale hoeveelheid tyd wat u elke dag sit by die werk, by u huis, tydens kursusse en ontspanning. Dit sluit in tyd wat u agter 'n lessenaar deurbring, met vriende sosialiseer, lees, of sit of le en televisie kyk.

(4a) Hoeveel totale tyd sit u gewoonlik op 'n weeksdag?

_____ ure _____ minute

(4b) Hoeveel totale tyd sit u gewoonlik op 'n dag oor die naweek?

_____ ure _____ minute

**INTERNASIONALE FISIEKE AKTIWITEITS VRAELYS
JONG- EN MIDDELJARIGE VOLWASSENES
GEWONE WEEK FORMAAT**

**LANK (LONG)
WEERGAWE VIR BETROUBAARHEID- EN GELDIGHEDSTOETSING
TELEFOON FORMAAT**

**[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY
CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS
VALUES.**

(SEE AINSWORTH ET AL)

Ons stel belang in die verskillende tipes fisieke aktiwiteit wat mense in hulle alledaagse lewe doen. Hierdie is deel van 'n veel groter studie wat wêreldwyd verig word. U antwoorde sal ons help om te verstaan hoe aktief ons is in vergelyking met mense van ander lande.

Ek gaan u nou 'n paar vrae vra oor die hoeveelheid tyd wat u weekliks aktief verkeer. Antwoord asseblief elke vraag, al dink u nie self u is aktief nie. Ek gaan vrae vra met betrekking tot die aktiwiteite wat u by die werk doen, om van plek na plek te kom, wat u as deel van u huis- en tuinwerk doen, en in u vrye tyd vir rekreasie, sport en oefening.

WERK-VERWANTE FISIEKE AKTIWITEIT

The eerste paar vrae hou verband met u beroep. Dit sluit betaalde werk, boerdery, vrywillige werk, kursusse bywoon en ander onbetaalde werk wat u nie by u eie huis doen nie in. Moet nie werk insluit wat u by u huis doen nie, soos huiswerk, tuinwerk, algemene onderhoud, of die omsien na u familie. Ek sal u later oor hierdie aktiwiteite vra.

(1a) Het u op die oomblik werk of onbetaalde werk wat u nie by die huis doen nie?

Ja _____
Nee _____ Skip to 2a
Weier
Weet nie

Die volgende vrae het betrekking tot fisieke aktiwiteite wat u in 'n gewone week as deel van betaalde of onbetaalde werk doen. Dit sluit nie die tyd in wat u spandeer om na u werkplek te reis nie.

(1b) Dink nou aan al die stremmende aktiwiteite wat u by u werk sou doen, wat harde fisieke inspanning vereis. Sulke aktiwiteite sal u harder as gewoonlik laat asemhaal. Voorbeelde van die soort aktiwiteite sluit in: swaar voorwerpe ophang, grawe, groot pakkies dra, trappe klim of swaar konstruksie werk. Dink nou net aan die fisieke aktiwiteite wat u vir ten minste 10 minute op 'n slag doen.

Hoeveel dae in 'n gewone week beoefen u sulke stremmende fisieke aktiwiteite as deel van u werk?

_____ dae per week

(1c) Hoeveel tyd in totaal spandeer u aan stremmende fisieke aktiwiteit op een van daardie dae as deel van u werk?

_____ ure _____ minute

(1d) Die volgende vraag verwys na die hoeveelheid tyd wat u in 'n gewone week spandeer aan aktiwiteite wat matige inspanning vereis. Die soort aktiwiteite behoort jou effens harder as gewoonlik te laat asemhaal, byvoorbeeld ligte vragte dra. Dink nou net aan sulke aktiwiteite wat u vir ten minste vir 10 minute op 'n slag doen.

Hoeveel dae in 'n gewone week beoefen u sulke matige fisieke aktiwiteite as deel van u werk?

_____ dae per week

(1e) Hoeveel tyd in totaal spandeer u op een van daardie dae aan matige fisieke aktiwiteit as deel van u werk?

_____ ure _____ minute

(1f) Dink nou aan die hoeveelheid tyd wat u vir ten minste 10 minute op 'n slag as deel van u werk stap. Dit sluit nie die tyd in wat u spandeer om na en van werk af te reis nie.

Hoeveel dae in 'n gewone week stap u as deel van u werk?

_____ dae per week

Weier

Weet nie

(1g) Hoeveel tyd in totaal stap u op een van daardie dae as deel van u werk?

_____ ure _____ minute

(1h) As deel van u werk, stap u gewoonlik teen:

_____ 'n Vinnige pas

_____ 'n Gemiddelde pas

_____ 'n Stadige pas

DEEL 2: FISIEKE VERVOERS AKTIWITEITE

(2a) Ek gaan u nou 'n paar vrae vra oor die tipe vervoer wat u in 'n gewone week gebruik om van plek na plek te reis, insluitende werk toe en terug, winkels, flielk ensovoorts.

Hoeveel dae in 'n gewone week maak u gebruik van 'n motor, bus trein of trem?

_____ dae per week

Weier

Weet nie

(2b) Hoeveel tyd in totaal spandeer u op een van daardie dae in 'n motor, bus, trein of enige ander vorm van vervoer?

_____ ure _____ minute

(2c) Dink nou aan die hoeveelheid tyd wat u sou fietsry werk toe, om alledaagse take uit te voer, of om van plek na plek te reis. Sluit net die kere in wat u vir ten minste 10 minute op 'n slag fietsry.

Hoeveel dae in 'n gewone week ry u fiets om van plek na plek te reis?

_____ dae per week

Weier

Weet nie

(2d) Hoeveel tyd in totaal ry u fiets op een van daardie dae om van plek na plek te reis?

_____ ure _____ minute

(2e) As u gewoonlik fietsry, ry u teen:

_____ 'n Vinnige pas wat u baie harder as gewoonlike laat asemhaal;

_____ 'n Gemiddelde pas wat u effens harder as normaal laat asemhaal;

_____ 'n Stadige pas wat geen verandering in u asemhaling noodsaak nie

(2f) Dink nou aan die hoeveelheid tyd wat u in 'n gewone week stap na en van u werkplek of skool, om take uit te voer of om van plek na plek te reis. Dit sluit net die kere wat u vir ten minste 10 minute op 'n slag stap in

Hoeveel dae in 'n gewone week stap u om van plek na plek te reis?

_____ dae per week

Weier

Weet nie

(2g) Hoeveel tyd in totaal stap u op een van daardie dae, met die doel om van plek na plek te reis?

_____ ure _____ minute

(2h) Om van plek tot plek te reis, stap u gewoonlik teen:

_____ 'n Vinnige pas wat u baie harder as gewoonlike laat asemhaal;

_____ 'n Gemiddelde pas wat u effens harder as normaal laat asemhaal;

_____ 'n Stadige pas wat geen verandering in u asemhaling noodsaak nie

DEEL 3: HUISWERK, INSTANDHOUDING, EN FAMILIE VERSORGING

(3a) Die volgende vrae het betrekking tot die fisieke aktiwiteite wat u in 'n gewone week doen in en om die huis, byvoorbeeld huiswerk, tuinwerk, algemene instandhouding en familie versorging.

Dink nou eers aan al die fisieke aktiwiteite wat harde fisiese inspanning vereis tydens tuinwerk. Sulke stremmende aktiwiteite sal u harder as gewoonlik laat asemhaal, byvoorbeeld swaar voorwerpe ophang, hout kap, grawe en sneeu skoffel. Dink weereens net aan die aktiwiteite wat u vir ten minste 10 minute op 'n slag doen.

Hoeveel dae in 'n gewone week beoefen u sulke stremmende fisieke aktiwiteite as deel van u tuinwerk?

_____ dae per week

Weier

Weet nie

(3b) Hoeveel tyd in totaal spandeer u aan stremmende fisieke aktiwiteit op een van daardie dae as deel van u tuinwerk?

_____ ure _____ minute

(3c) Die volgende vraag verwys na die hoeveelheid tyd wat u in 'n gewone week spandeer aan aktiwiteite wat matige inspanning vereis tydens u tuinwerk. Die soort aktiwiteite behoort jou effens harder as gewoonlik te laat asemhaal, byvoorbeeld ligte vragte dra, hark, vensters was en vee. Dink nou net aan sulke aktiwiteite wat u vir ten minste vir 10 minute op 'n slag doen.

Hoeveel dae in 'n gewone week beoefen u sulke matige fiskieke aktiwiteite as deel van u tuinwerk?

_____ dae per week

Weier

Weet nie

(3d) Hoeveel tyd in totaal spandeer u op een van daardie dae aan matige fisieke aktiwiteit as deel van u tuinwerk?

_____ ure _____ minute

(3e) Die volgende vraag verwys na die hoeveelheid tyd wat u in 'n gewone week spandeer aan aktiwiteite wat matige inspanning vereis tydens u huiswerk. Voorbeelde sluit in ligte vragte dra, trappe klim, vee, vloere skrop en vensters was. Dink nou net aan sulke aktiwiteite wat u vir ten minste vir 10 minute op 'n slag doen.

Op hoeveel dae in 'n gewone week beoefen u sulke matige fiskieke aktiwiteite as deel van u huiswerk?

_____ dae per week

Weier

Weet nie

(3f) Hoeveel tyd in totaal spandeer u op een van daardie dae aan matige fisieke aktiwiteit as deel van u huiswerk?

_____ ure _____ minute

DEEL 4: REKREASIE, SPORT EN ONTSPANNING FISIEKE AKTIWITEIT

(4a) Die volgende paar vrae het betrekking tot alle fisieke aktiwiteite wat u in 'n gewone week doen vir rekreasie, sport, oefening of ontspanning. Moet asseblief nie aktiwiteite insluit wat u alreeds in die vorige vrae genoem het nie.

Sonder om die bogenoemde stap-tyd te noem, op hoeveel dae in 'n gewone week stap u vir ten minste 10 minute op 'n slag in u ontspannings tyd?

_____ dae per week

Weier

Weet nie

(4b) Hoeveel tyd in totaal stap u op een van daardie dae, in u ontspanningstyd?

_____ ure _____ minute

(4c) Teen wat se pas stap u gewoonlik in u ontspanningstyd? Stap u teen:

_____ 'n Vinnige pas wat u baie harder as gewoonlike laat asemhaal;

_____ 'n Gemiddelde pas wat u effens harder as normaal laat asemhaal;

_____ 'n Stadige pas wat geen verandering in u asemhaling noodsaak nie

(4d) Dink nou aan ander fisiese aktiwiteite wat u in u vrye tyd vir ten minste 10 minute op 'n slag doen.

Dink nou eers aan al die fisieke aktiwiteite wat u in u vrye tyd doen, wat harde fisiese inspanning vereis. Voorbeelde sluit in aerobiese dans, hardloop aktiwiteite soos sokker, vinnige fietsry of vinnige swem. [‘n Vinnige pas wat u baie harder as gewoonlike laat asemhaal]

Hoeveel dae in 'n gewone week beoefen u sulke stremmende fisieke aktiwiteite in u vrye tyd?

_____ dae per week

Weier

Weet nie

(4e) Hoeveel tyd in totaal spandeer u aan stremmende fisieke aktiwiteit op een van daardie dae in u vrye tyd?

_____ ure _____ minute

(4f) Die volgende vraag verwys na die hoeveelheid tyd wat u in 'n gewone week se vrye tyd spandeer aan aktiwiteite wat matige inspanning vereis. Voorbeelde sluit in fietsry en swem teen 'n gemiddelde tempo, en tennis dubbels. Dink nou net aan sulke aktiwiteite wat u vir ten minste vir 10 minute op 'n slag doen.

Op hoeveel dae in 'n gewone week beoefen u sulke matige fisieke aktiwiteite in u vrye tyd?

_____ dae per week

Weier

Weet nie

(4g) Hoeveel tyd in totaal spandeer u op een van daardie dae aan matige fisieke aktiwiteit in u vrye tyd?

_____ ure _____ minute

DEEL 5: TYD SITLENDE SPANDEER

(5a) Die laaste vrae het betrekking tot die totale hoeveelheid tyd wat u elke dag sit by die werk, by u huis, tydens kursusse en ontspanning. Dit sluit in tyd wat u agter 'n lessenaar deurbring, met vriende sosialiseer, lees, of sit of lê en televisie kyk. Moet asseblief nie die tyd insluit wat in u 'n motor sit, waarom u my alreeds vertel het nie.

Hoe lank sit u gewoonlik op 'n weeksdag?

_____ ure _____ minute

(5b) Hoe lank sit u gewoonlik op 'n dag oor die naweek?

_____ ure _____ minute

XHOSA TRANSLATION
Form 2
INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
YOUNG AND MIDDLE-AGED ADULTS
SHORT USUAL WEEK VERSION 8

VERSION FOR RELIABILITY AND VALIDITY TESTING
TELEPHONE FORMAT

[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS VALUES. (SEE AINSWORTH ET AL)]

Sinomdla wokwazi ngeentlobo zemidlalo eshukumisa umzimba ezenziwa ngabantu njengenxalenye yezinto abazenza imihla ngemihla ebomini babo. Oku kuyinxalenye yophando olunabileyo olwenziwayo kumazwe amaninzi apha elizweni. Iimpendulo zakho ziyakusinceda ekubeni sazi okokuba ingaba sikhuluphele kangakananina xa kuthelekiswa namanye amazwe.

Ndizakubuza ngexesha olichithayo kwiveki nje eqhelekileyo usenza imidlalo eshukumisa umzimba.

Nceda uphendule umbuzo ngamnye nokokuba awuzithathi njengomntu okhulupheleyo. Ndizakuba ndikubuza ngezinto ozenzayo emsebenzini, ukusuka kwenye indawo uye kwenye, njengomsebenzi wakho wasendlwini naseyadini, nangexesha lakho lokuzonwabela, ezemidlalo okanye imidlalo eshukumisa umzimba.

- 1a** Ngoku, cinga ngezinto ozenza ngamandla amakhulu ezikwenza udinwe kakhulu othi uzenze kwiveki nje eqhelekileyo. I zinto ozenza ngamandla amakhulu zikwenza uphefumlele phezulu kakhulu kunohlobo omele kuphefumla ngalo yaye zingaquka ukuphakamisa izinto ezinzima, ukomba, ama-aerobics, ukubalekisa ibhayisekile. Cinga nje ngezizinto uzenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza intsuku ezingaphi evekini imidlalo eshukumisa umzimba oyenza ngokukhawuleza?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Xela yonke imisebenzi]

_____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 2a*]

- 1b** Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo eshukumisa umzimba ngoku khawuleza?..

___ iiyure ___ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo evekini usenza imidlalo eshukumisa umzimba ngamandla amakhulu?"

___ iiyure ___ imizuzu evekini]

- 2a Ngoku, cinga ngemidlalo oyenza ngamandla aphakathi onokuba uyayenza kwiveki nje eqhelekileyo. Le imidlalo yenza ukuba uphefumle kakhulwana kunesiqhelo yaye ingaquka ukuphakamisa imithwalo elula, ukukwela ibhayisekile isantya nje esiqhelekileyo, ukunye okanye umdlalo wentenetya. Sukubala nezinto ezinjengo kuhamba. Kwakhona, Cinga nje ngezizinto ozenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza iintsuku ezingaphi evekini imidlalo eshukumisa umzimba oyenza ngokukhawuleza?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Xela yonke imisebenzi]

___ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 3a*]

- 2b Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo eshukumisa umzimba ngokukhawuleza?..

___ iiyure ___ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo evekini usenza imidlalo eshukumisa umzimba ngamandla aphakathi nje?"

___ iiyure ___ imizuzu evekini

- 3a Ngoku, cinga ngexesha olichithayo kwi veki nje eqhelekileyo uhamba. Oku kuquka ukuhamba usekhaya okanye ukuhamba usemsebenzini, Ukuhamba usuka kwenye indawo usiya kwenye, nako nokuphini ukuhamba onokukwenza njengokuzonwabisa, imidlalo eshukumisa umzimba, ezemidlalo, okanye ngexesha lakho lokuphumla.

Zingaphi iintsuku evekini othi uhambe isithuba esingangemizuzu elishumi?

[ingcaciso yomqondisi: Cinga nje ngokuhamba okwenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Xela yonke imisebenzi]

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 4a*]

3b Lingakanani lilonke ixesha olichitha ekuhambeni kwisuku ngalinye ?

____ iiyure ____ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo ekuhambeni kwisithuba seveki?"

____ iiyure ____ imizuzu evekini]

3c Uye uhambe ngesantya esingakanani? Uhamba ngesantya esi:

____ phezulu kakhulu, nto leyo ekwenza uphefumlele phezulu kunemo yesiqhele

____ phakathi, ntoleyo ekwenza uphefumlele phezulwana kunemo yesiqhelo

____ phantsi, nto leyo engenzi lutshintsho kwindlela ophefumla ngayo yesiqhelo.

[Umqondisi uyagrumba: Kufunwa oliqikelelayo. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, okanye ngokwemisebenzi ayenzayo, indlela yothutho, namanqanaba exesha lokuphumla, buza: "Lingakanani lilonke ixesha olichithayo uhamba ngesantya esiphantsi kwisithuba seveki?"

____ iiyure ____ imizuzu evekini]

Le mibuzo yokugqibela imalunga nexesha olichithayo uhleli phantsi emsebenzini, ekhaya, ngexesha owenza ngalo umsebenzi okanye ngexesha lokuphumla. Oku kungaquka ixesha olichitha uhleli edesikeni, undwendwele abahlobo,ufunda uhleli okanye ungqengqile ubukele umabonakude.

4a Lingakanani lilonke ixesha olichitha uhleli phantsi evekini (ie Ngomvulo uyokutsho ngolwesihlanu)?

____ - iiyure ____ imizuzu

[ingcaciso yomqondisi: Bala nexesha olichitha ungqengqile nolichitha uhleli..]

[Umqondisi uyagrumba: Kufunwa oliqikelelayo. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza:

“Lingakanani lilonke ixesha olichithayo uhleli evekini?”

____iiyure ____ imizuzu evekini]

4b Lingakanani lilonke ixesha olichitha uhleli phantsi ngomgqibelo nange Cawa?

____ - iiyure ____ imizuzu

**FORM 6
XHOSA TRANSLATION**

**INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
YOUNG AND MIDDLE-AGED ADULTS
LONG
USUAL WEEK VERSION 8**

**VERSION FOR RELIABILITY AND VALIDITY TESTING
TELEPHONE FORMAT**

**[NOTE: EXAMPLES OF ACTIVITIES MAY BE REPLACED BY
CULTURALLY RELEVANT EXAMPLES WITH THE SAME METS
VALUES.**

(SEE AINSWORTH ET AL)

Sinomdla wokwazi ngeentlobo zemidlalo eshukumisa umzimba ezenziwa ngabantu njengenxalenye yezinto abazenza imihla ngemihla ebomini babo. Oku kuyinxalenye yophando olunabileyo olwenziwayo kumazwe amaninzi apha elizweni. Iimpendulo zakho ziyakusinceda ekubeni sazi okokuba ingaba sikhuluphele kangakananina xa kuthelekiswa namanye amazwe.

Ndizakubuza ngexesha olichithayo kwiveki nje eqhelekileyo usenza imidlalo eshukumisa umzimba.

Nceda uphendule umbuzo ngamnye nokokuba awuzithathi njengomntu okhulupheleyo. Ndizakuba ndikubuza ngezinto ozenzayo emsebenzini, ukusuka kwenye indawo uye kwenye, njengomsebenzi wakho wasendlwini naseyadini, nangexesha lakho lokuzonwabela, ezemidlalo okanye imidlalo eshukumisa umzimba.

Imidlalo eshukumisa umzimba eyayanyaniswa nomsebenzi

Imibuzo yokuqala ingomsebenzi wakho. Oku kuquka umsebenzi ohlawulelwayo, ukulima nokufuya, ukuvolontiya, neminye imisebenzi engahlawulelwayo oyenzayo kude ngaphandle ekhayeni lakho. Sukubala nemisebenzi enokuba uyayenza ngaphakathi ekhaya enjengemisebenzi yasendlwini, eyaseyadini, ukulungisa izinto, okanye ukujonga usapho lwakho. Ndizakukubuza kamva ngezo izinto.

- 1a** Ingaba uyaphangela ngoku okanye kukhona umsebenzi owenzayo ongahlawulelwayo kude ngaphandle nekhaya lakho?

[Ingcaciso yomqondisi: Oku kuquka izifundo zamawonga okanye ezo ingezozamawonga, ikwaquka nomsebenzi wobuvolontiya, nexesha oluchitha ufuna umsebenzi. Ayiquki umsebenzi wasendlwini okanye waseyadini ongahlawulelwayo, okanye ukujonga abantu abaxhomekeke kuwe. Leyo into iyakubuzwa kwelinye icandelo]

Ewe _____ (yiya kumbuzo 1b)

Hayi _____ (tsibela kumbuzo 2a)

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

Imibuzo engezantsi ingemisebenzi eshukumisa umzimba othi uyenze evekini njengenxalenye yomsebenzi ohlawulelwayo okanye ongahlawulelwayo. Oku akuquki ukuya nokubuya emsebenzini.

- 1b Okokuqala, cinga ngezinto ozenza ngamandla amakhulu ezikwenza udinwe kakhulu othi uzenze kwiveki nje eqhelekileyo *njengenxalenye yomsebenzi wakho*. I zinto ozenza ngamandla amakhulu zikwenza uphefumlele phezulu kakhulu kunohlobo omele ukuphefumla ngalo yaye zingaquka ukuphakamisa izinto ezinzima, ukomba, imisebenzi yokwakha enzima, okanye ukonyuka izituphu. Cinga nje ngezizinto uzenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza intsuku ezingaphi evekini imidlalo eshukumisa umzimba oyenza ngokukhawuleza njengenxalenye yomsebenzi wakho?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Umsebenzi uquka lowo uhlawulelwayo nalowo ungahlawulelwayo. Xela yonke imisebenzi nalowo wobuvolontiya]

_____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 1d*]

- 1c Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo eshukumisa umzimba ngoku khawuleza njengenxalenye yomsebenzi wakho?..

_____ iiyure _____ imizuzu

[i_ ngcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, okanye liquka ixesha elichithwa kusenziwa imisebenzi eyahlukeneyo ehlawulelwayo nengahlawulelwayo, buza: “Lingakanani lilonke ixesha olichithayo evekini usenza imisebenzi eshukumisa umzimba oyenza ngamandla amakhulu khawuleza *njengenxalenye yomsebenzi wakho?*”

_____ iiyure _____ imizuzu evekini]

- 1d Ngoku, cinga ngemisebenzi oyenza ngamandla aphakathi nje onokuba uyayenza *njengexalenye yomsebenzi wakho*. Le imisebenzi yenza ukuba uphefumle kakhulwana kunesiqhelo yaye ingaquku ukuphakamisa imithwalo elula, ukukhwela ibhayisekile ngesantya nje esiqhelekileyo, ukunye okanye umdlalo wentenetya. Sukubala nezinto ezinjengo kuhamba. Kwakhona, Cinga nje ngezizinto ozenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza iintsuku ezingaphi evekini imisebenzi eshukumisa umzimba oyenza ngamandla aphakathi nje *njengexalenye yomsebenzi wakho*?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Umsebenzi uquka lowo uhlawulelwayo nalowo ungahlawulelwayo. Bala yonke imisebenzi]

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 1f*]

- 1e Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo eshukumisa umzimba ngamandle apha?

____ iiyure ____ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, okanye liquka ixesha elichithwa kusenziwa imisebenzi eyahlukeneyo ehlawulelwayo nengahlawulelwayo, buza: "Lingakanani lilonke ixesha olichithayo evekini usenza imidlalo eshukumisa umzimba oyenza ngamandla amakhulu *jengexalenye yomsebenzi wakho*?"

____ iiyure ____ imizuzu evekini

- 1f Ngoku, cinga ngexesha olichithayo kwi veki nje eqhelekileyo uhaba isithuba semizuzu elishumi njengexalenye yomsebenzi wakho. Nceda ungakubali ukuhaba usiya okanye uvela emsebenzini.

Zingaphi iintsuku evekini othi uhambe njengexalenye yomsebenzi wakho?

[ingcaciso yomqondisi: Cinga nje ngokuhamba okwenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi: Xela yonke imisebenzi]

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 2a*]

1g **Lingakanani lilonke ixesha olichitha ekuhambeni kwisuku ngalinye njengenxalenye yomsebenzi wakho?**

_____ iiyure _____ imizuzu

[ingcaciso yomqondisi: Cinga nje ngokuhamba kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, okanye liquka ixesha alichitha kwimisebenzi eminininzi, buza: “Lingakanani lilonke ixesha olichithayo ekuhambeni kwisithuba seveki?”

_____ iiyure _____ imizuzu evekini]

1h **Xa uhamba njengenxalenye yomsebenzi wakho, uhamba ngesantya esingakanani? Uhamba nge**

_____ santya esiphezulu kakhulu;

_____ ngesantya esiphakathi

_____ ngesantya esiphantsi.

[ingcaciso yomqondisi:Uhamba nge]

_____ santya esi phezulu kakhulu, nto leyo ekwenza uphefumlele phezulu kunemo yesiqhelo

_____ ngesantya esi phakathi, ntoleyo ekwenza uphefumlele phezulwana kunemo yesiqhelo

_____ ngesantya esi phantsi, nto leyo engenzi lutshintsho kwindlela ophefumla ngayo yesiqhelo.

[Umqondisi uyagrumba: Kufunwa isantya sesiqhelo. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, okanye ngokwemisebenzi ayenzayo, indlela yothutho, namanqanaba exesha lokuphumla, buza: “Lingakanani lilonke ixesha olichithayo uhamba ngesantya esiphantsi kwisithuba seveki njengenxalenye yomsebenzi wakho?”

_____ iiyure _____ imizuzu evekini]

Icandelo 2: Ukushukumisa umzimba usuka kwenye indawo usiya kwenye.

2a **ngoku, ndizakubuza oya ngayo ezindaweni kwiveki nje eqhelekileyo, indawo ezinjengokuya emsebenzini, ezivenkileni, ukuya kubukela imiboniso bhanyabhanya njalo njalo.**

Zingaphi iintsuku evekini othi uhambe ngesithuthi esinjengo loliwe, ibhasi, imoto okanye ittram?

____ intsuku ngeveki

uyala [Umqondisi: Sukufunda]

akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 2c*]

- 2b Lingakanani lilonke ixesha olichitha uhamba *ngemoto, ibhasi, uloliwe okanyi naluphi na uhlobo lwesithuthi?*

____ iiyure ____ imizuzu

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: “Ungandixelela lilonke ixesha olichithayo uhamba ngesithuthi evekini?”

____ iiyure ____ imizuzu evekini]

- 2c Ngoku cinga *ngokukhwela ibhayisikile* usiya okanye ubuya emsebenzini, usenza iingxakana omele ukuzenza ngemini, usuka kwenye indawo usiya kwenye. Cinga kuphela ngokukhwela ibhayisikile isithuba esingange mizuzu elishumi kwixesha ngalinye.

Zingaphi iintsuku evekini othi uhambe ngebhayisikile *usuka kwenye indawo usiya kwenye?*

[ingcaciso yomqondisi: Cinga kuphela ngokukhwela ibhayisikile isithuba esingange mizuzu elishumi kwixesha ngalinye.]

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 2f*]

- 2d Lingakanani lilonke ixesha olichitha uhamba ngebhayisikile ngeveki enye, *usuka kwenye indawo usiya kwenye?*

____ iiyure ____ imizuzu

[ingcaciso yomqondisi: Cinga kuphela ngokukhwela ibhayisikile isithuba esingange mizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: “Lingakanani lilonke ixesha olichitha uhamba ngebhayisikile evekini *usuka kwenye indawo usiya kwenye?*”

____ iiyure ____ imizuzu evekini]

- 2e Xa uhamba ngebhayisekile uye uhambe ngesantya esingakanani?
Uhamba nge
___ santya esi phezulu kakhulu, nto leyo ekwenza uphefumlele phezulu
kunemo yesiqhelo
___ ngesantya esi phakathi, ntoleyo ekwenza uphefumlele hpezulwana
kunemo yesiqhelo
___ ngesantya esi phantsi, nto leyo engenzi lutshintsho kwindlela
ophefumla ngayo yesiqhelo.

- 2f Ngoku, cinga ngexesha olichithayo kwi veki nje eqhelekileyo uhamba
isithuba semizuzu elishumi, usiya okanye ubuya emsebenzini, usenza
ingxakana zakho zosuku okanye usuka kwenye indawo usiya kwenye.
Cinga nje ngokuhamba kangangemizuzu elishumi kwixesha ngalinye.]

Zingaphi iintsuku evekini othi uhambe ngazo usuka kwenye indawo usiya
kwenye?

[ingcaciso yomqondisi: Cinga nje ngokuhamba okwenza
kangangemizuzu elishumi kwixesha ngalinye.]

___ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye
akazi, tsibela *kumbuzo 3a*]

- 2g Lingakanani lilonke ixesha olichitha ekuhambeni kwisuku ngalinye
usuka kwenye indawo usiya kwenye?
___ iiyure ___ imizuzu
[ingcaciso yomqondisi: Cinga nje ngokuhamba kangangemizuzu
elishumi kwixesha ngalinye.]
[Umqondisi uyagrumba: Kufunwa umyinge wexasha ngemini
enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba
ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo
ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo
ekuhambeni usiyaya kukhwela isithuthi?"
___ iiyure ___ imizuzu evekini]

- 2h Xa uhamba usuka kwenye indawo usiya kwenye o, uhamba ngesantya
esingakanani? Uhamba nge
___ santya esiphezulu kakhulu;
___ ngesantya esiphakathi
___ ngesantya esiphantsi.

[ingcaciso yomqondisi: Uhamba nge]

___santya esi phezulu kakhulu, nto leyo ekwenza uphefumlele phezulu
kunemo yesiqhele
___santya esi phakathi, ntoleyo ekwenza uphefumlele phezulwana
kunemo yesiqhelo
___santya esi phantsi, nto leyo engenzi lutshintsho kwindlela ophefumla
ngayo yesiqhelo.

**Indawo 3 Umsebenzi wasendwini, Ukulungisa izinto endlwini, nokujonga
usapho**

- 3a** Ngoku ndizakukubuza ngemisetyenzana eshukumisa umzimba onokuba
uyayenza apha ngaphakathi ekhayeni lakho,umzekelo, umsebenzi
wasendlwini, ukusebenza egadini, umsebenzi waseyadini, ukullungisa
izintoyinto okanye ukujonga usapho lwakho.

Okokuqala cinga ngezinto ozenza ngamandla amakhulu ezikwena udinwe
kakhulu othi uzenze *egadini okanye eyadini*. I zinto ozenza
ngokukhawuleza okukhulu zikwenza uphefumlele phezulu kakhulu
kunohlobo omele ukuphefumla ngalo yaye zingaquka ukuphakamisa
izinto ezinzima, ukomba, ukunqunqa iinkuni okanye ukududula ikhephu.
Kwakhona cinga nje ngezizinto ozenza kangangemizuzu elishumi
kwixesha ngalinye.

Uyenza intsuku ezingaphi evekini imisetyenzana eshukumisa umzimba
eyadini okanye egadini oyenza ngamandla amakhulu?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza
kangangemizuzu elishumi kwixesha ngalinye.]

___intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye
akazi, tsibela *kumbuzo 3c*]

- 3b** Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza
imisebenzi eshukumisa umzimba ngamandla amakhulu *egadini okanye
eyadini?*.

___iiyure___ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza
kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini
enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba
ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo
ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo
evekini usenza imisebenzi eshukumisa umzimba oyenza
ngamandla amakhulu *egadini okanye eyadini?*"

___iiyure___ imizuzu evekini]

- 3c Ngoku, cinga ngemisebenzi oyenza ngamandla aphakathi nje onokuba uyayenza *egadini okanye eyadini* Le imidlalo yenza ukuba uphefumle kakhulwana kunesiqhelo yaye ingaquku ukuphakamisa imithwalo elula, ukutshayela, ukuhlamba iifesitile, nokuharika. Kwakhona, Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza iintsuku ezingaphi evekini imisebenzi eshukumisa umzimba oyenza *egadini okanye eyadini*?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 3e*]

- 3d Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imisebenzi eshukumisa umzimba egadini okanye eyadini?.

____ iiyure ____ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: "Lingakanani lilonke ixesha olichithayo evekini usenza imisebenzi eshukumisa umzimba *egadini okanye eyadini*?"

____ iiyure ____ imizuzu evekini

- 3e Ngoku, cinga ngemisebenzi oyenza ngamandla aphakathi nje onokuba uyayenza *ngaphakathi endlwini*. Le imisebenzi yenza ukuba uphefumle kakhulwana kunesiqhelo yaye ingaquku ukuphakamisa imithwalo elula, ukutshayela, ukuhlamba iifesitile, nokuharika. Kwakhona, Cinga nje ngezizinto ozenza kangangemizuzu elishumi kwixesha ngalinye.

Uyenza iintsuku ezingaphi evekini imisebenzi eshukumisa umzimba oyenza *ngaphakathi endlwini*?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]

[ingcaciso yomqondisi: Uyenza iintsuku ezingaphi evekini imisebenzi eshukumisa umzimba *oyenza ngaphakathi endlwini*?

____ intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 4a*]

- 3f **Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imisebenzi eshukumisa umzimba ngamandla aphaath *phakathi endwini*?**

___ **iiyure** ___ **imizuzu**

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza

kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa oliqikelelayo ngemini enye.

Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye

imini, buza: “Lingakanani lilonke ixesha olichithayo evekini

usenza imisebenzi eshukumisa umzimba *ngaphakathi endwini*?”

___ **iiyure** ___ **imizuzu** evekini

Indawo 4: Ukushukumisa umzimba ngexesha lokuzonwabisa, kwezemidlalo, ngexesha lokuphumla

- 4a **Ngoku ndizakukubuza ngemidlalo eshukumisa umzimba oyenzayo evekini, kuphela ngexesha lokuzonwabisa, kwezemidlalo okanye ngexesha lakho lokuphumla. Nceda UNGAyibali le imidlalo usele uyikhankanyile ngaphambili.**

Xa ungakubalanga oku ukuhamba osele ukukhankanyile, Zingaphi iintsuku evekini othi uhambe ngazo *ngexesha lakho lokuphumla*?

[ingcaciso yomqondisi: Cinga nje ngokuhamba okwenza

kangangemizuzu elishumi kwixesha ngalinye.]

___ **intsuku** ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 4d*]

- 4b **Lingakanani lilonke ixesha olichitha ekuhambeni *ngexesha lakho lokuphumla* ngosuku olunye?**

___ **iiyure** ___ **imizuzu**

[ingcaciso yomqondisi: Cinga nje ngokuhamba kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngeminie

enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba

ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo

ngenye imini, buza: “Lingakanani lilonke ixesha olichithayo

ekuhambeni ngeveki *ngexesha lakho lokuphumla*?”

___ **iiyure** ___ **imizuzu** evekini]

- 4c Xa uhamba *ngexesha lakho lokuphumla*, uhamba ngesantya esingakanani? Uhamba nge
____ santya esiphezulu kakhulu;
____ santya esiphakathi
____ santya esiphantsi.
[ingcaciso yomqondisi: Uhamba nge
____ santya esi phezulu kakhulu, nto leyo ekwenza uphefumlele phezulu kunemo yesiqhele
____ ngesantya esi phakathi, ntoleyo ekwenza uphefumlele phezulwana kunemo yesiqhelo
____ ngesantya esi phantsi, nto leyo engenzi lutshintsho kwindlela ophefumla ngayo yesiqhelo].
- 4d Ngoku ndizakukubuza ngemidlalo eshukumisa umzimba onokuba uyayenza *ngexesha lakho lokuphumla*, imisebenzi ethi ithathe kangangemizuzu elishumi.
- Okokuqala, cinga ngezinto ozenza ngamandla amakhuluza ezikwenza udinwe kakhulu othi uzenze *ngexesha lakho lokuphumla*. Imizekelo ingaquka ama aerobics, ukubaleka, ukubalekisa ibhayisekile, okanye ukuqubha ngokukhawuleza.
[ingcaciso yomqondisi: I zinto ozenza ngokukhawuleza okukhulu zikwenza uphefumlele phezulu kakhulu kunohlobo omele kuphefumla ngalo].
- Uyenza intsuku ezingaphi evekini imidlalo eshukumisa umzimba *ngexesha lakho lokuphumla* oyenza ngamandla amakhulu?
[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]
____ intsuku ngeveki
Uyala [Umqondisi: Sukufunda]
Akazi [Umqondisi: Sukufunda]
[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye akazi, tsibela *kumbuzo 4f*]
- 4e Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo eshukumisa umzimba oyenza ngamandla amakhulu *ngexesha lakho lokuphumla*?
____ iiyure ____ imizuzu
[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza kangangemizuzu elishumi kwixesha ngalinye.]
[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza: “Lingakanani lilonke ixesha olichithayo

evekini usenza imisebenzi eshukumisa umzimba ngoku khawuleza
ngexesha lakho lokuphumla?
____iiyure____ imizuzu evekini]

- 4f Ngoku, cinga ngemidlalo eshukumisa umzimba oyenza ngamandla
aphakathi nje onokuba uyayenza *ngexesha lakho lokuphumla*. Imizekelo
ingaquka ukukhwela ibhayisekile ngesantyha nje esiqhelekileyo,
ukuqubha ngessantyha nje esiqhelekileyo nokudlala intenetya.
Kwakhona, Cinga nje ngezizinto ozenza kangangemizuzu elishumi
kwixesha ngalinye.

[ingcaciso yomqondisi: Le imidlalo yenza ukuba uphefumle
kakhulwana kunesiqhelo

Uyenza iintsuku ezingaphi evekini imidlalo eshukumisa umzimba oyenza
ngexesha lakho lokuphumla?

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza
kangangemizuzu elishumi kwixesha ngalinye.]

____intsuku ngeveki

Uyala [Umqondisi: Sukufunda]

Akazi [Umqondisi: Sukufunda]

[Umqondisi: Ukuba umbuzwa akaphendulanga, uyala okanye
akazi, tsibela *kumbuzo 5a*]

- 4g Lingakanani lilonke ixesha olichithayo kwisuku ngalinye usenza imidlalo
eshukumisa umzimba ngamandla aphakathi nje *ngexesha lakho
lokuphula?*

____iiyure____ imizuzu

[ingcaciso yomqondisi: Cinga nje ngezi zinto ozenza
kangangemizuzu elishumi kwixesha ngalinye.]

[Umqondisi uyagrumba: Kufunwa umyinge wexesha ngemini
enye. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba
ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo
ngenye imini, buza: “Lingakanani lilonke ixesha olichithayo
evekini usenza imidlalo eshukumisa umzimba ngamandla
aphakathi nje *ngexesha lakho lokuphumla?*”

____iiyure____ imizuzu evekini

Indawo 5: Ixesha Olichitha Uhleli phantsi

- 5a** Le mibuzo yokugqibela imalunga nexesha olichithayo uhleli phantsi emsebenzini, ekhaya, ngexesha owenza ngalo umsebenzi okanye ngexesha lokuphumla. Oku kungaquka ixesha olichitha uhleli edesikeni, undwendwele abahlobo,ufunda, uhleli okanye ungqengqile ubukele umabonakude.

Lingakanani lilonke ixesha olichitha uhleli phantsi kwisuku ngalinye evekini?

___ iiyure ___ imizuzu

[ingcaciso yomqondisi: Bala nexesha olichitha ungqengqile nolichitha uhleli..]

[Umqondisi uyagrumba: Kufunwa oliqikelelayo. Ukuba umbuzwa akanakuphendula ngenxeni yokokuba ixesha alichithayo ngemini enye lahluke kakhulu kwalichithayo ngenye imini, buza:

“Lingakanani lilonke ngeveki ixesha olichithayo uhleli?”

___ iiyure ___ imizuzu evekini]

- 5b** Lingakanani lilonke ixesha olichitha uhleli phantsi ngosuku lwempelaveki?

___ iiyure ___ imizuzu

APPENDIX L. SPECIFIC RECOMMENDATIONS FOR FURTHER RESEARCH.

More specific comments and recommendations on the IPAQ in the South African group can be made for the International Working Group. It is important to document these recommendations for future research in this area. These comments refer to the specific forms used for testing which are found in the appendix.

Demographics (form 9):

- Subjects were unsure what the size of the population of their residence/location was and mostly guessed.
- Years of education should specify that it is *inclusive* of grades 1 and 2 (i.e Sub a and b). Some subjects who had failed years of school or varsity were unsure whether to include this as they said it was part of their education.
- Age on last birthday. Many subjects put their previous age instead of their current age. Perhaps this question should be "*How old are you today?*"

Subject Tracking (form 13):

- South Africa does not have states and the form should rather request postal address. The allocated spacing on the form to write the address was inadequate.

Long and short IPAQ (form 7 and form 3):

- There was confusion when administering both questionnaires on the same visit. Subjects thought they had already reported a component of activity, not realizing that there were two separate questionnaires, even though this is explained, "up front".

- Many subjects inquired whether sexual activity was included as a category on the form. They said it made them breathe faster than normal and lasted for more than 10 minutes at a time and should be included. It is not known how many subjects included sexual activity, however we know the CSAs would not have been worn, so it will not show on their energy expenditure in the validation.
- Quite a number of subjects from urban areas engaged in water sports including swimming, paddling, surfing and windsurfing which meant they did not wear the CSAs during these activities. Thus, this will result in an underestimation of leisure time activity for these persons.
- Subjects were unsure whether to include “child rearing” as moderate activity since it did not really make them breathe harder than normal and did not last for 10 minutes continuously, but was rather of an intermittent nature over a few hours.
- Time spent sitting in a vehicle is not specifically included in the sitting section (question 4) of the short questionnaire (form 3). Most subjects did not include this because the questionnaire did not ask for it. However the long IPAQ (form 7) specifically requires the subject NOT to include it since it has been included in the transport section (Part 2). This question can be made clearer for the short form.
- Only 2.5 % of subjects reported using a bicycle as transport. This question was not very relevant in South Africa.
- Many subjects go out their offices and walk during their lunch breaks at work, either to fetch lunch, go to shops or to get some fresh air. There was some confusion whether this should be included as leisure time walking or transport walking or work

walking as it could fall in any of these categories. A standard answer had to be made, and we decided that it was in the work category since it was during working hours.

- We felt that by excluding any walking that was less than 10 minutes at a time, we were excluding a large volume of occupational and transport physical activity. For example, individuals may walk 8 minutes to accompany their child to school and return, and they would not have included this in the questionnaire as the activity was not continuous, and was for less than 10 minutes. Also, because the CSA's do count physical activity for less than 10 minutes at a time, (and in our case, we were not able to distinguish the intensity of the continuous activity), we have a built in error that the CSA's will be counting activity that the questionnaires exclude.

General comments

- All the questions (especially the long form 3) ask "*how many days one does "x" or "y" activity?*". As written, it makes the assumption that one participates in the activity already, and that creates an expectation. In some cases, subjects felt pressurized to give an answer, and we had to continuously assure them that they could just say "*no days or zero*" if they did not engage in that activity. Perhaps a question could be asked at the beginning of each category "*Do you ever work in your garden/ yard? If so, ...*" or "*Do you ever engage in leisure time activities/exercise? If so, ...*"
- In the home/gardening category, as well as leisure/exercise and job category, the amount of vigorous activity is asked first and then the amount of moderate activity. Often subjects answered the first simply because they did not know that there was a

second question in the same category. Then the interviewer would have to go back and say *"Of the 3 hours of activity at work you reported, how much of it was vigorous, and how much was moderate"*. It might have been useful if the questions were together in the first place, eg *"Do you ever do physical activities in the garden? If yes, how much time would be moderate and how much time vigorous?"* or even putting moderate before vigorous.

- It would be very useful to have a preamble beforehand explaining the definition of moderate and vigorous, ALL their physical symptoms and explain that each activity reported should last for at least 10 minutes at a time, instead of repeating the 10 minutes limit for each question. In our pilot studies we included a preamble like this and it was very helpful.
- Many subjects did activities which did not last 10 minutes continuously and could not include them. For example they might climb flights of stairs at work which takes them 5 minutes and they do this 4 times in a day. If one had to accumulate this, it would be equivalent to 20 minutes of vigorous activity at work which has not been reported!
- The energy expenditure (in METs) allocated for walking at a slow, moderate and vigorous pace, respectively is the same. For this analysis, we were told to use 3 METS for all walking, however, we feel, particularly in our sample, it may be more appropriate to weight walking according to pace. We were under the impression that anything less than moderate would not "count" toward the total moderate-to-vigorous energy expenditure (against which we measure criterion validity). Also, the wording in the IPAQ used for vigorous walking is the same as that for vigorous activity.

Additionally, from chapter three in this thesis, we found that using the instructions for “vigorous” walking from the IPAQ actually resulted in energy expenditure or MET level corresponding to vigorous activity.